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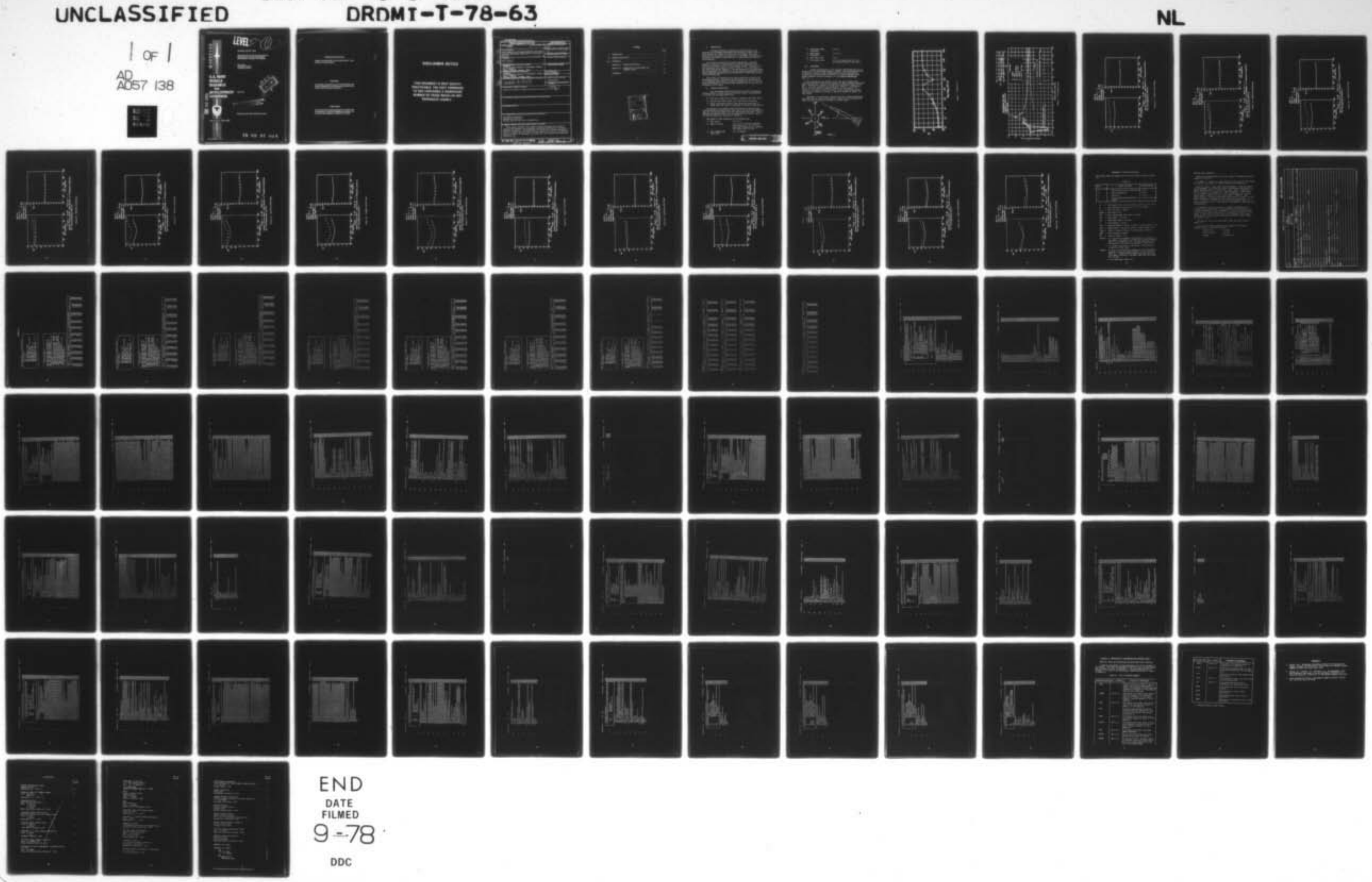

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TECHNICAL REPORT T-78-63

USER'S MANUAL FOR THE MARTIN–MARIETTA HIGH ANGLE OF ATTACK AERODYNAMIC METHODOLOGY FOR BODY-TAIL MISSILES

Gary C. Winn
Aeroballistics Directorate
Technology Laboratory

U.S. ARMY MISSILE RESEARCH AND DEVELOPMENT COMMAND

JUNE 1978

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Redstone Arsenal, Alabama 35809

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report documents the computer program developed by the Army to evaluate and implement an aerodynamic methodology developed by the Martin Marietta Corporation. The methodology was developed to predict aerodynamic forces on slender missile bodies with low aspect ratio tails at low and high angles of attack, at arbitrary roll angles for both transonic and supersonic velocities.

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I. INTRODUCTION

The Martin Marietta Corporation, Orlando Division, has developed an aerodynamic methodology and published a report (Ref. 1) under Contract No. DAAH01-74-C-0621 with the US Army. The report describes the development and application of semiempirical methods for predicting aerodynamic characteristics of slender body and body-tail configurations.

In an effort to evaluate the Martin Methodology, a computer program was developed to incorporate the various theoretical and empirical procedures called for in the Martin report. The results of this evaluation are covered in detail in Ref. 2. As a follow-up to the Martin Methodology analysis, a few modifications of the methodology were accomplished in an attempt to correct certain disagreements found between measured experimental data and associated predictions derived from the methodology.

This report is intended to be a user's guide for the use of the methodology program. The methods and procedures used in developing the aerodynamic methodology are covered extensively in Ref. 1 and only those modifications to the methodology implemented by the Army will be discussed in this report.

II. PROGRAM CAPABILITIES

The Aerodynamic Methodology Program can predict aerodynamic characteristics of slender body and body-tail missile configurations, to include the following predictions:

1) Body alone normal force, center of pressure, and axial force.
2) Isolated tail panel normal force and center of pressure.
3) Mutual interference effects that enable the prediction of normal force and center of pressure of body-tail combinations.

The program in its present form was developed to predict these characteristics for missiles with four fins in cruciform configuration, with the fin trailing edges flush with the missile body base. The fin numbering convention, as well as the conventions for angle of attack (α) and roll angle (ϕ), are shown in Figure 1.

The range of input parameters for the program are:

1)	Mach number	0.8 to 3.0
2)	Angle of attack	0 to 180 for isolated components (roll angle = 0). 0 to 45 for body-tail combinations at arbitrary roll angles from 0 to 180 .
3)	Tail leading edge sweep angle	0 to 70 degrees

4)	After-body length (calibers)	6 to 18
5)	Nose length (calibers)	1.5 to 3.5
6)	Tail taper ratio	0 to 1
7)	Tail aspect ratio	.5 to 2.0 (aspect ratio of two tail panels joined at root chord)

III. DISCUSSION

Certain modifications of the original methodology were incorporated into the methodology computer program. These modifications were an attempt to correct certain disagreements between experimentally obtained data and associated predictions from the methodology which became apparent during an evaluation of the original methodology (Ref. 2).

The modifications are limited to the body alone normal force prediction methods and involve the addition of newly obtained unpublished data. Specifically, equation 16, page 36 as depicted in Figure 20 of Ref. 1, has been eliminated and replaced by values of η (correlation factor for end effects) as shown in Figure 2 of this report. In addition, the crossflow drag coefficient versus crossflow Mach number curve shown in Figure 22a of Ref. 1, has been replaced by Figure 3 of this report.

Comparisons of predictions generated from the original methodology and those with the above modifications, compared with the experimental data, are shown in Figures 4 through 10 of this report.

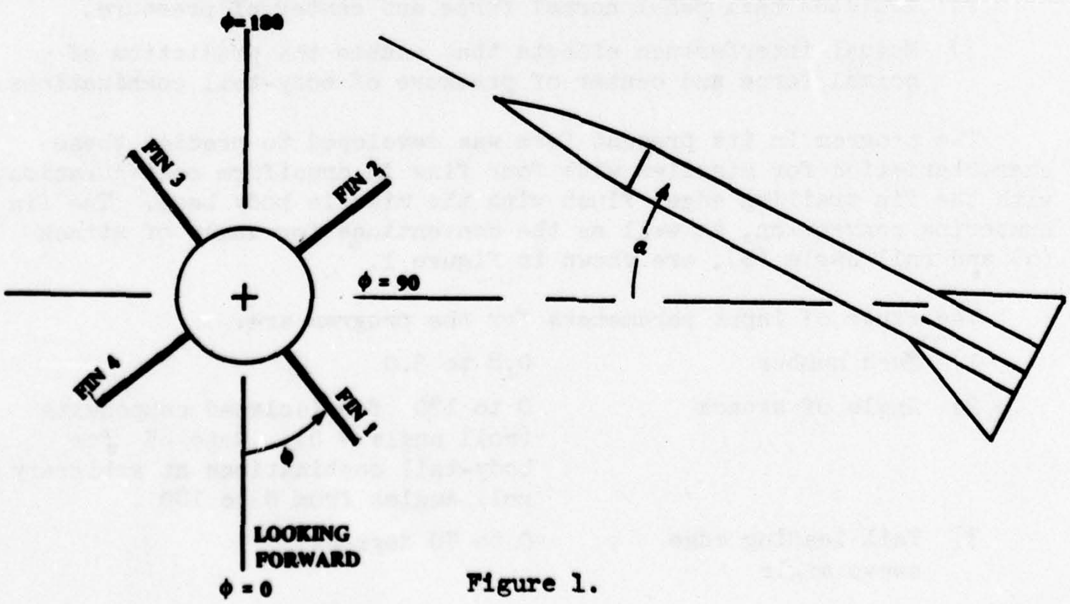


Figure 1.

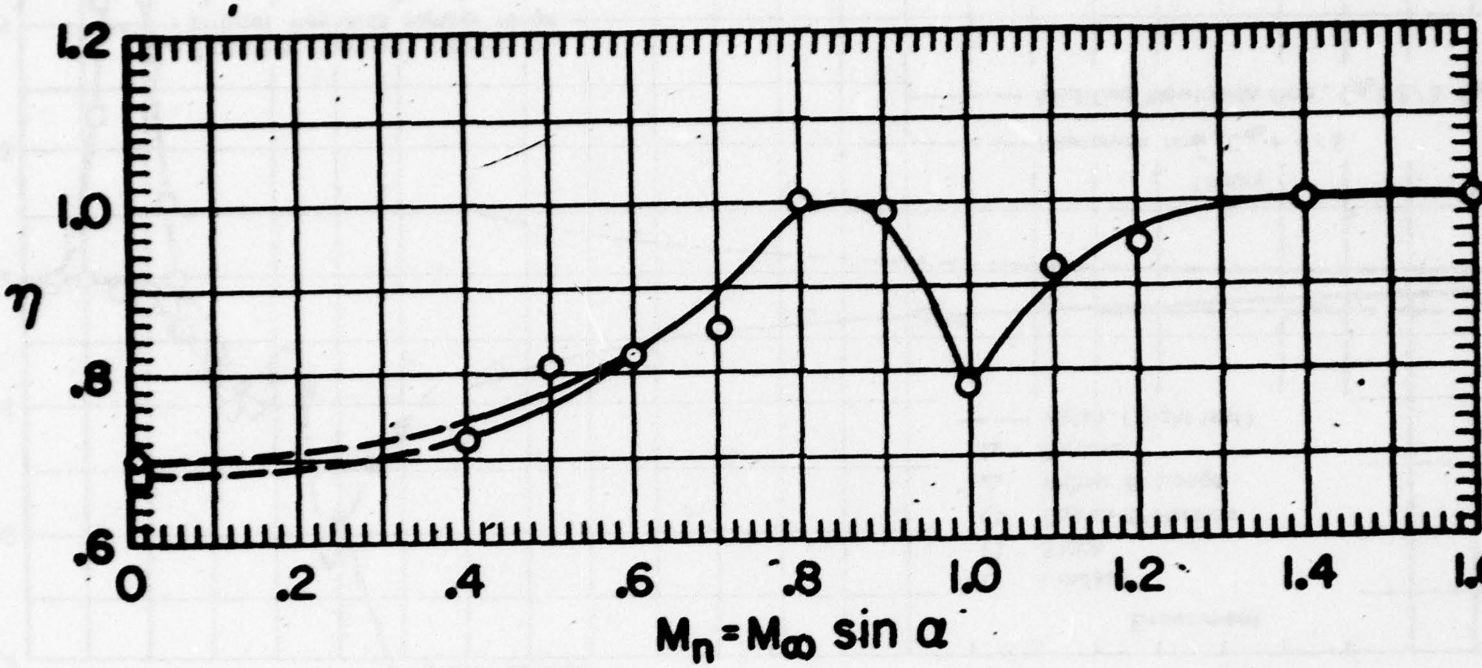


Figure 2. Values of η.

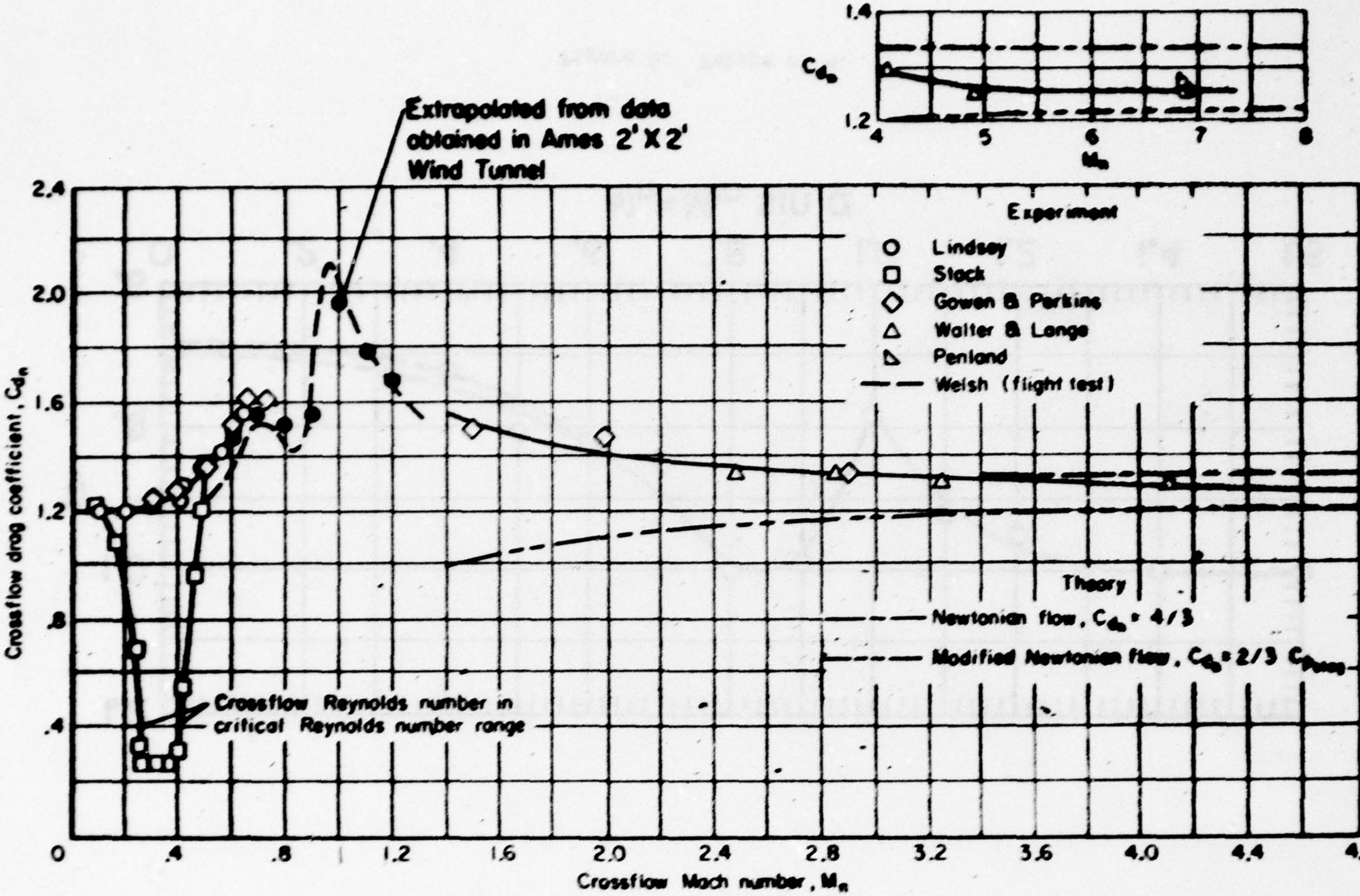


Figure 3. Unpublished data.

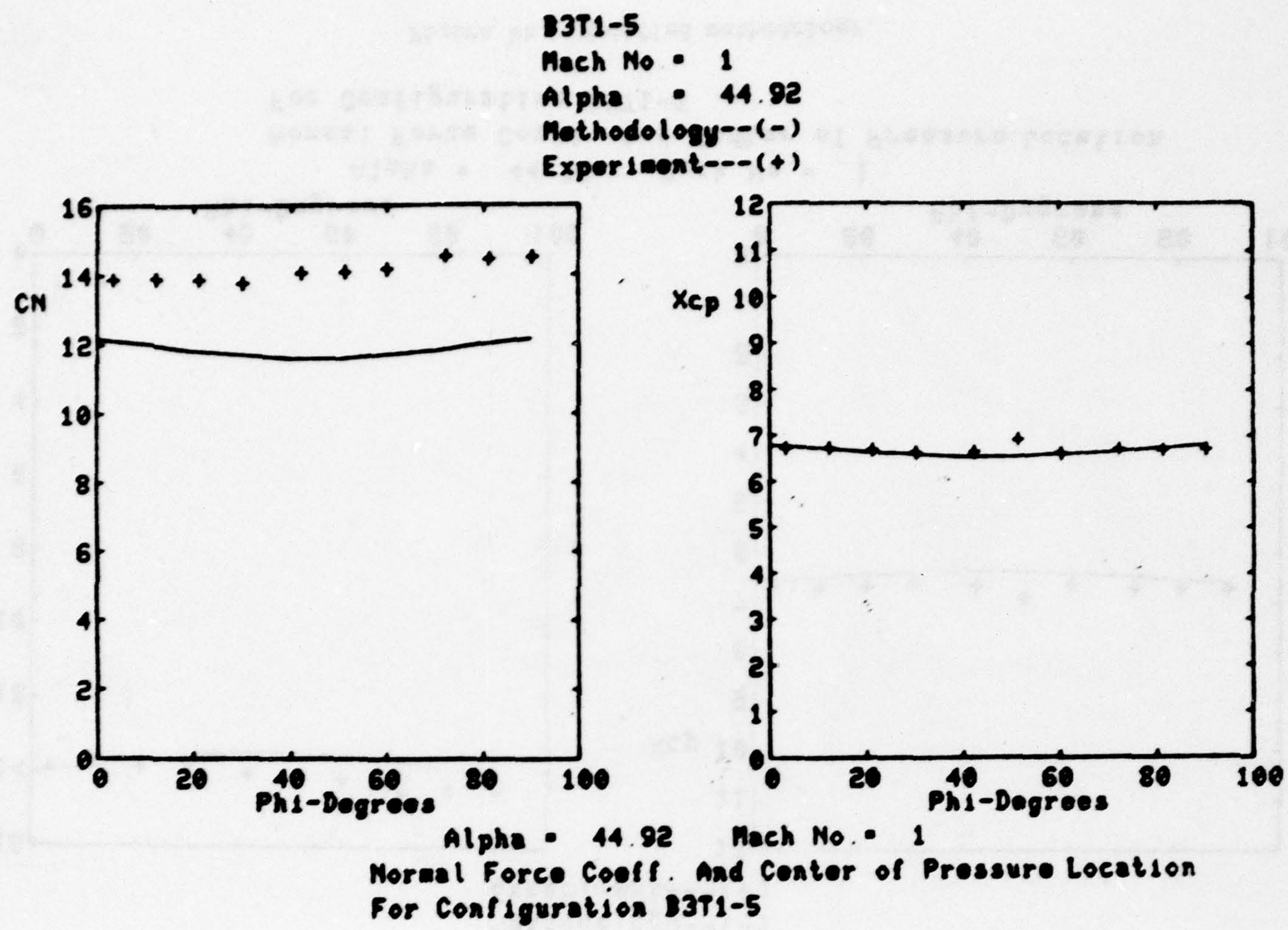
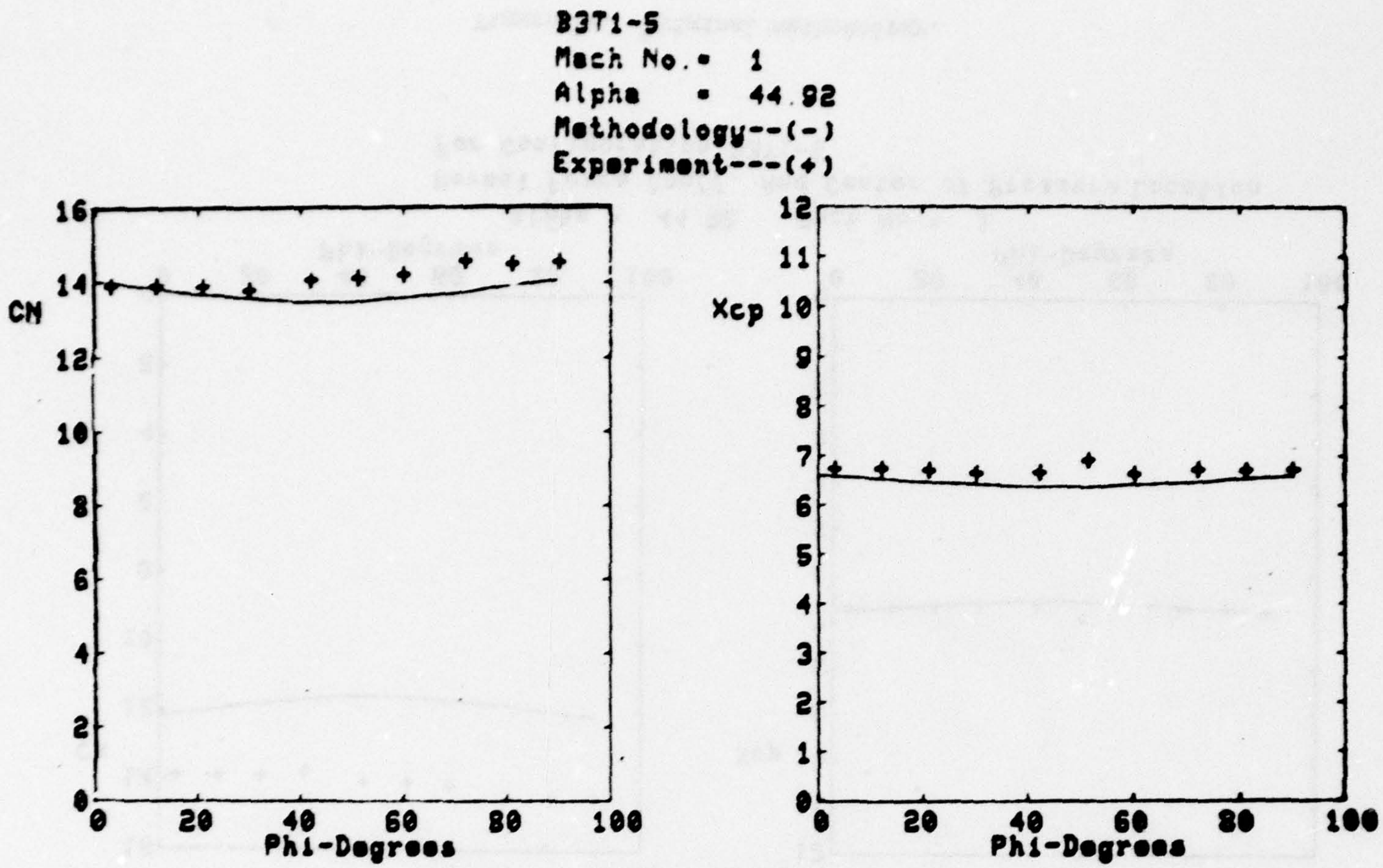
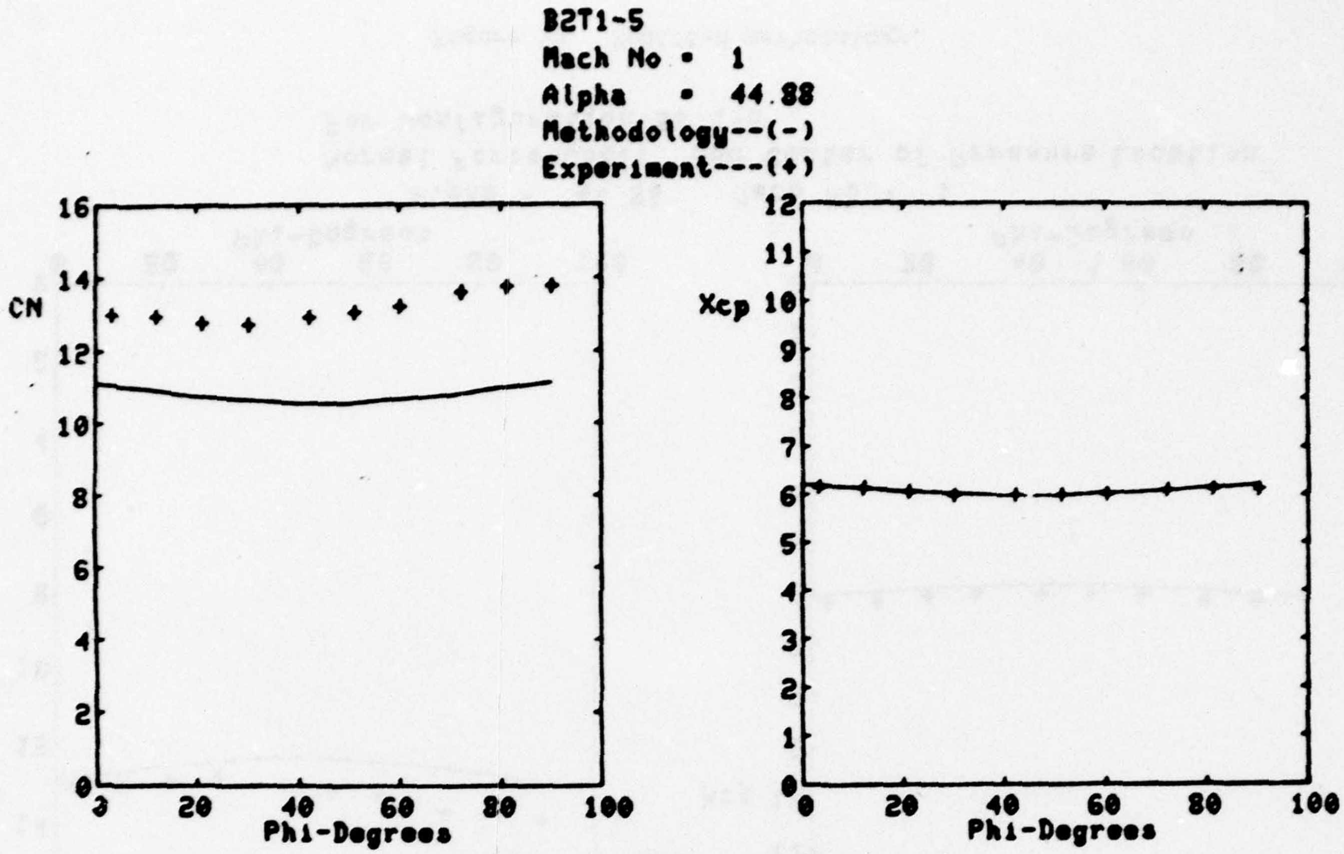


Figure 4a. Original methodology.



Alpha = 44.92 Mach No. = 1
Normal Force Coeff. And Center of Pressure Location
For Configuration B3T1-5

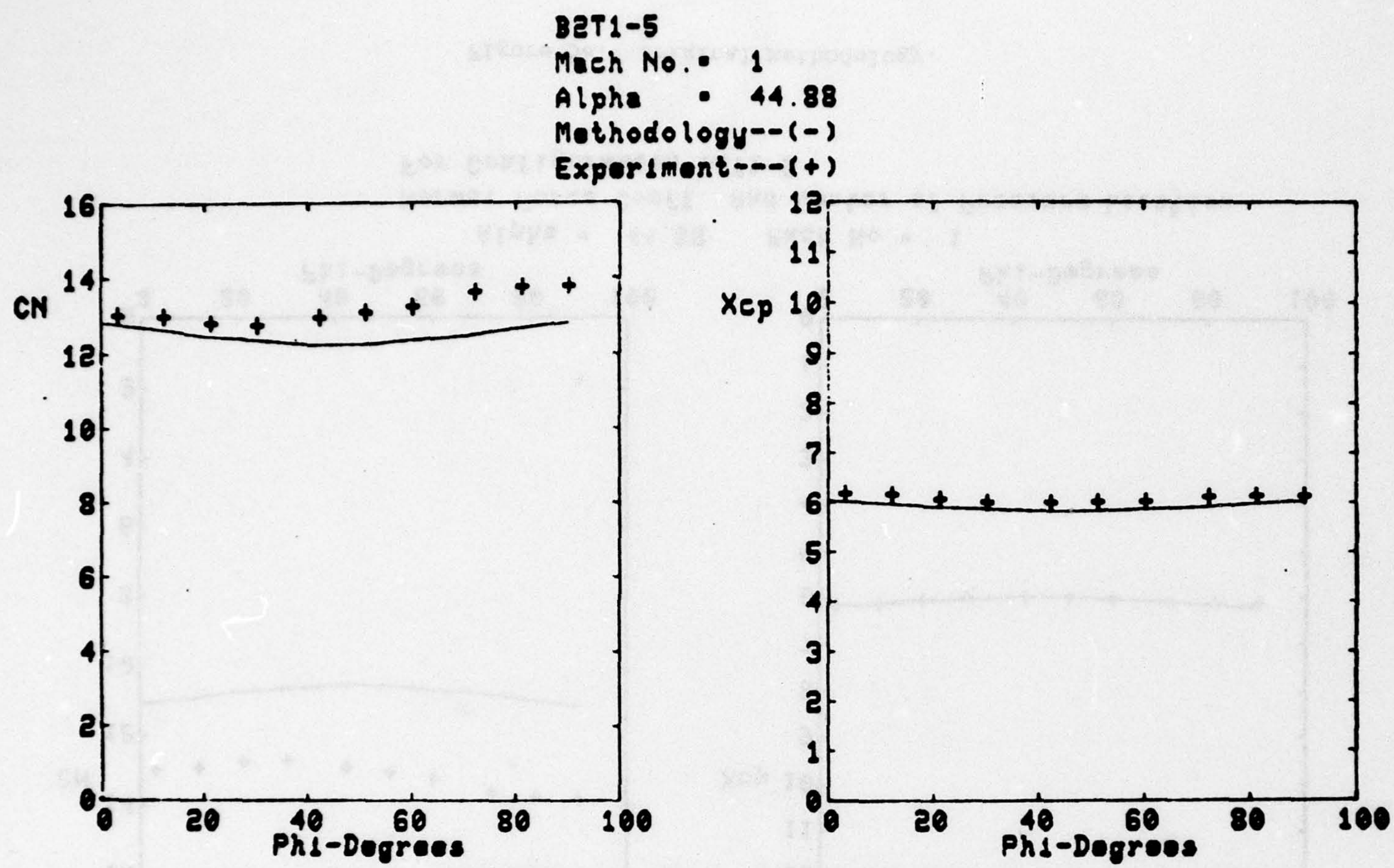
Figure 4b. Modified methodology.



Alpha = 44.88 Mach No. = 1

Normal Force Coeff. And Center of Pressure Location For Configuration B2T1-5

Figure 5a. Original methodology.



Alpha = 44.88 Mach No.= 1
Normal Force Coeff. And Center of Pressure Location
For Configuration B2T1-5

Figure 5b. Modified methodology.

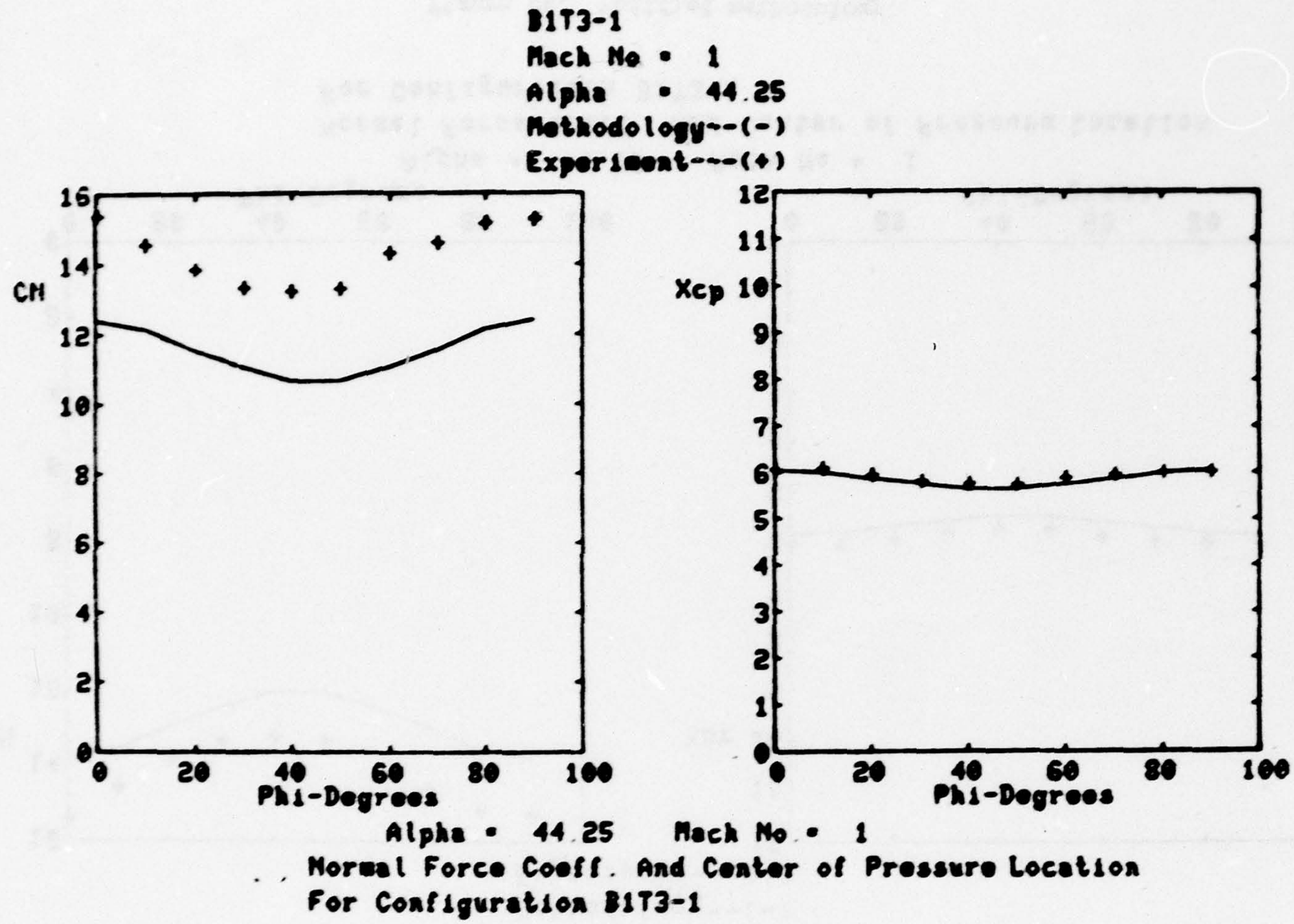


Figure 6a. Original methodology.

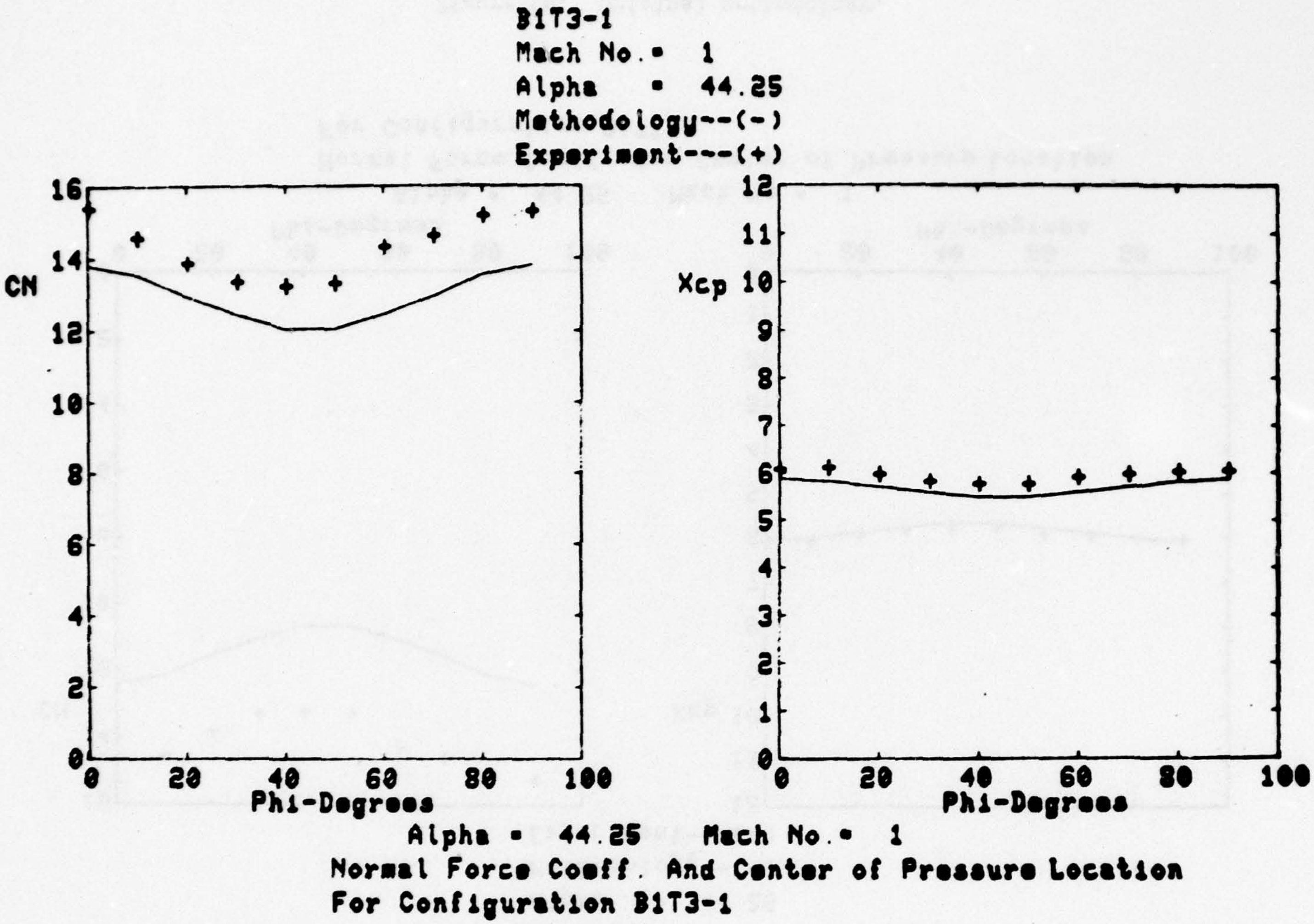


Figure 6b. Modified methodology.

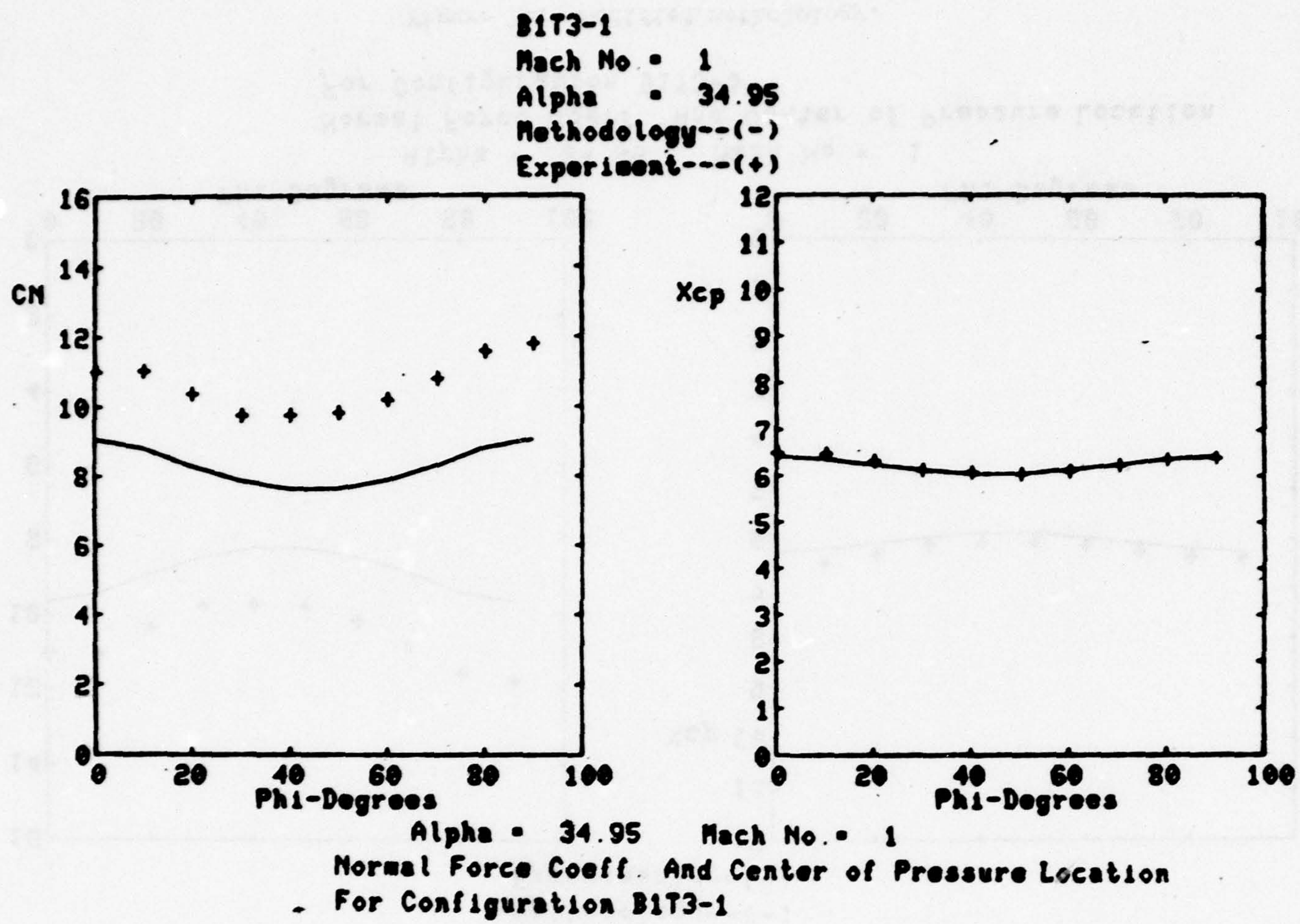
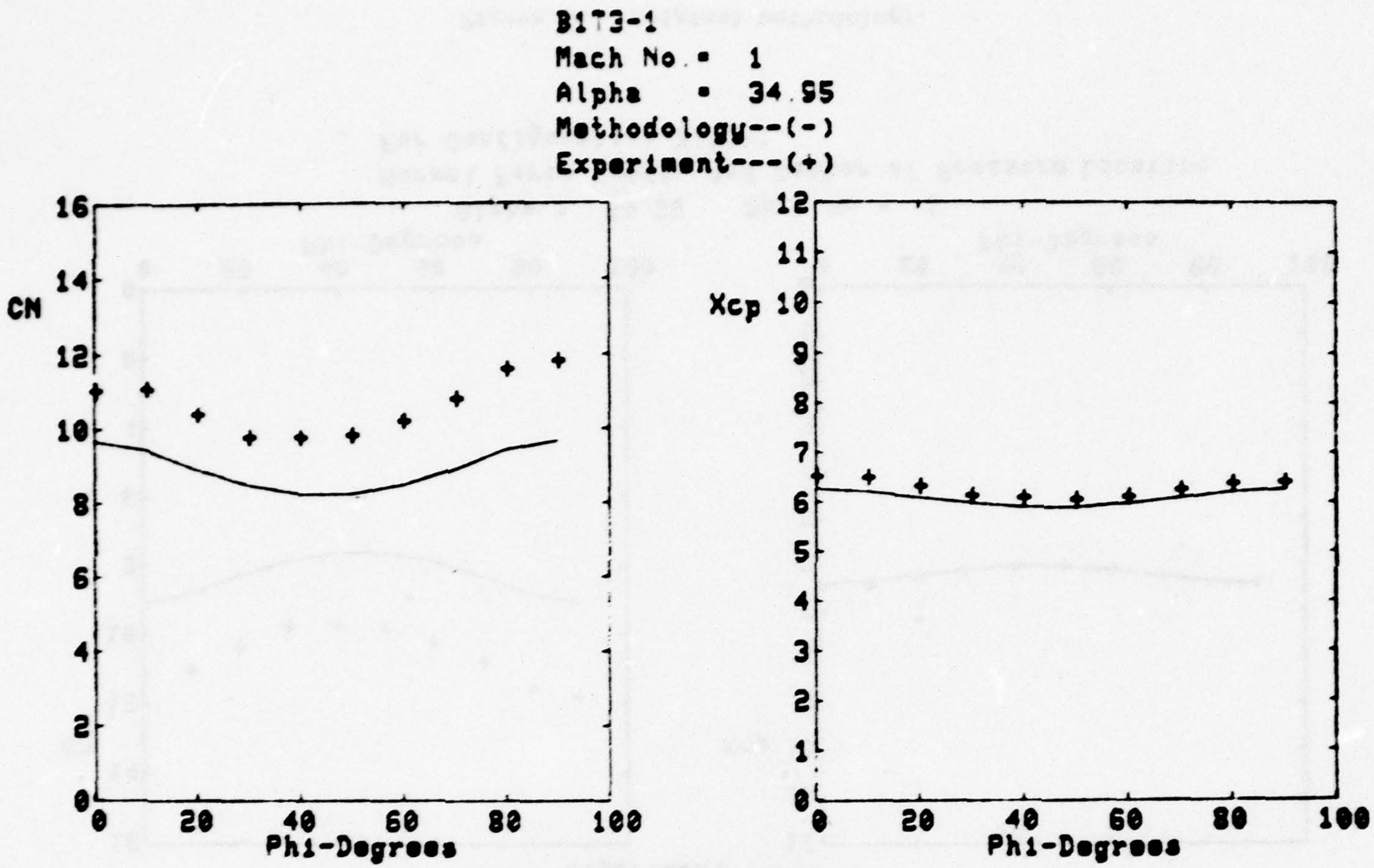
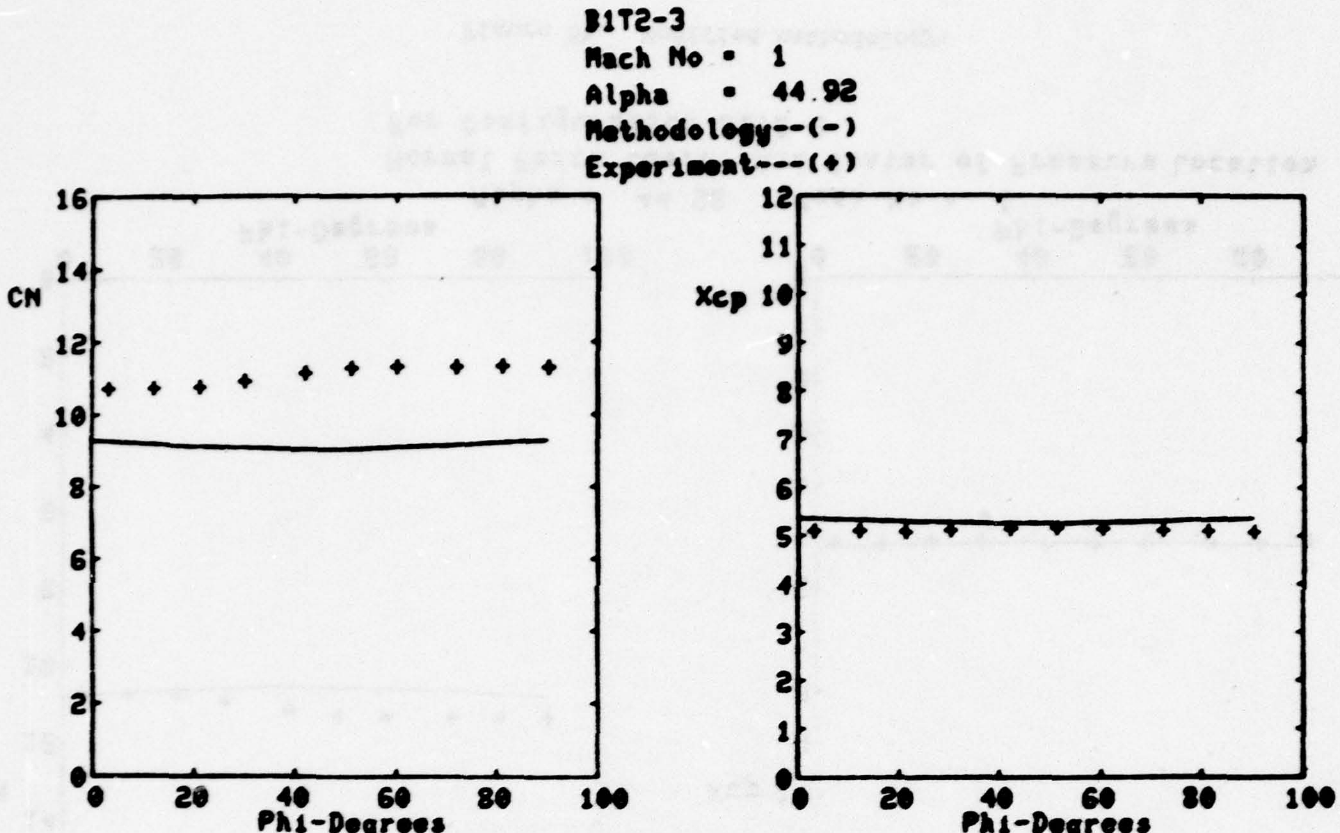


Figure 7a. Original methodology.



Alpha = 34.95 Mach No. = 1
Normal Force Coeff. And Center of Pressure Location
For Configuration B1T3-1

Figure 7b. Modified methodology.



Alpha = 44.92 Mach No. = 1
Normal Force Coeff. And Center of Pressure Location
For Configuration B1T2-3

Figure 8a. Original methodology.

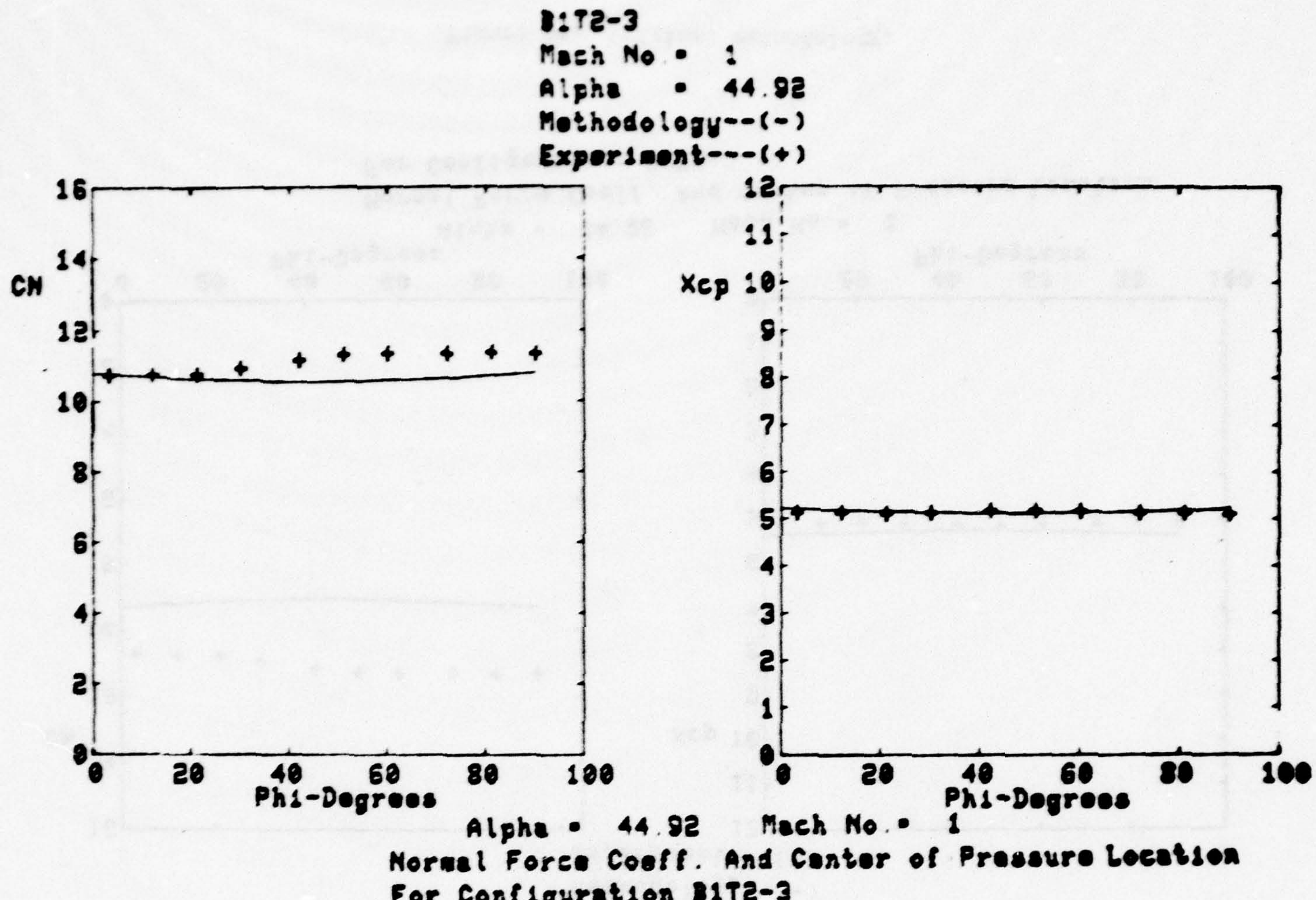


Figure 8b. Modified methodology.

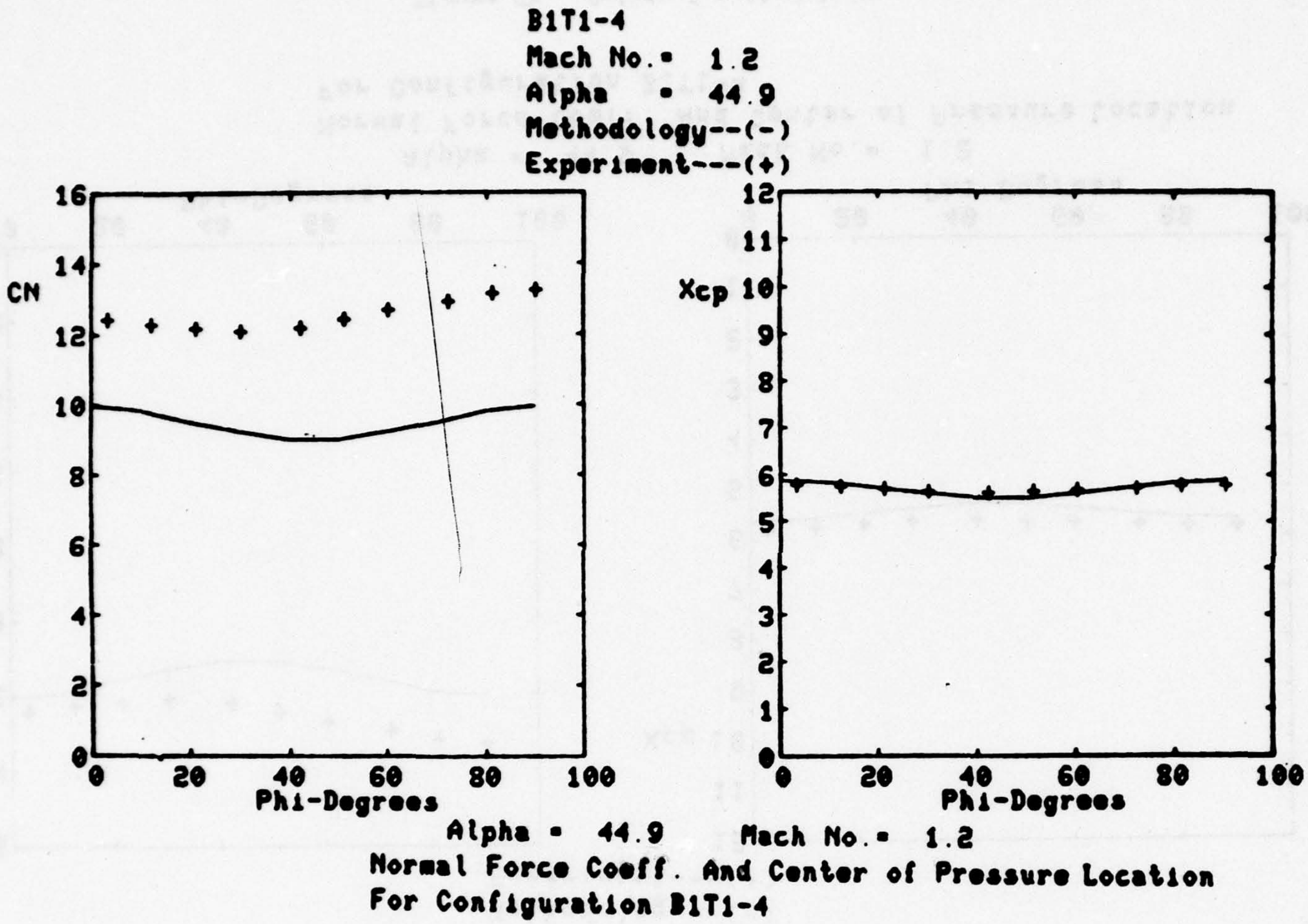


Figure 9a. Original methodology.

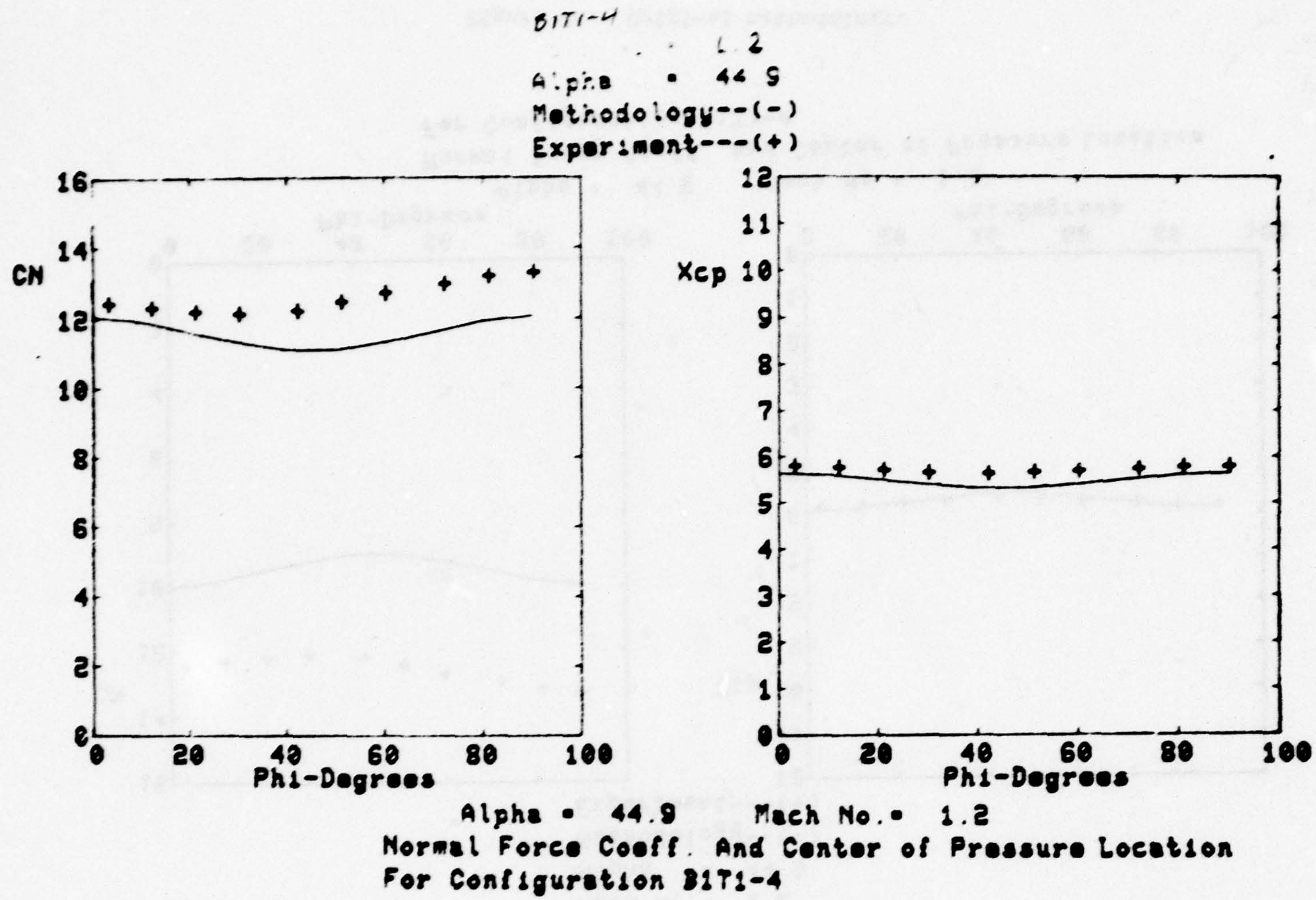
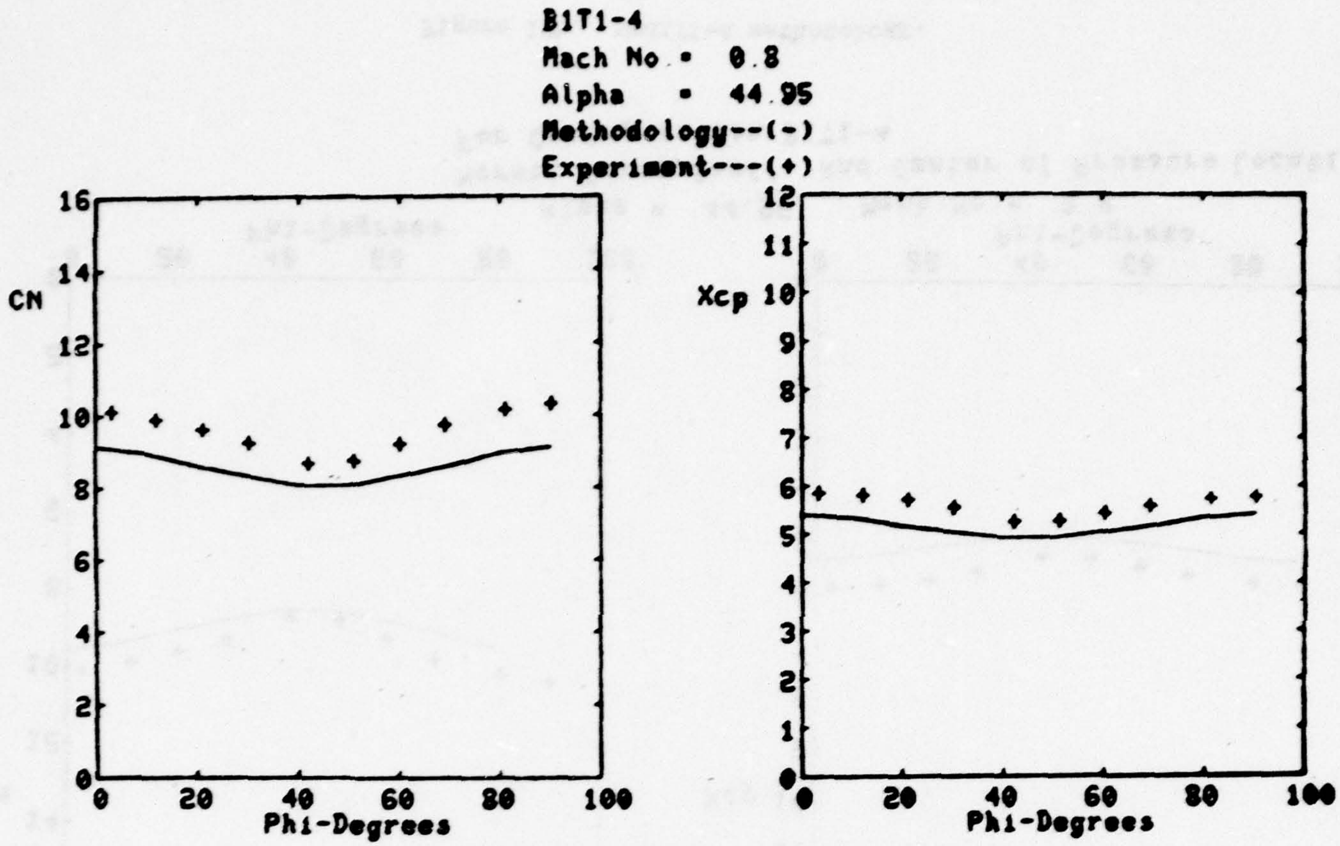


Figure 9b. Original methodology.



Alpha = 44.95 Mach No. = 0.8
Normal Force Coeff. And Center of Pressure Location
For Configuration B1T1-4

Figure 10a. Original methodology.

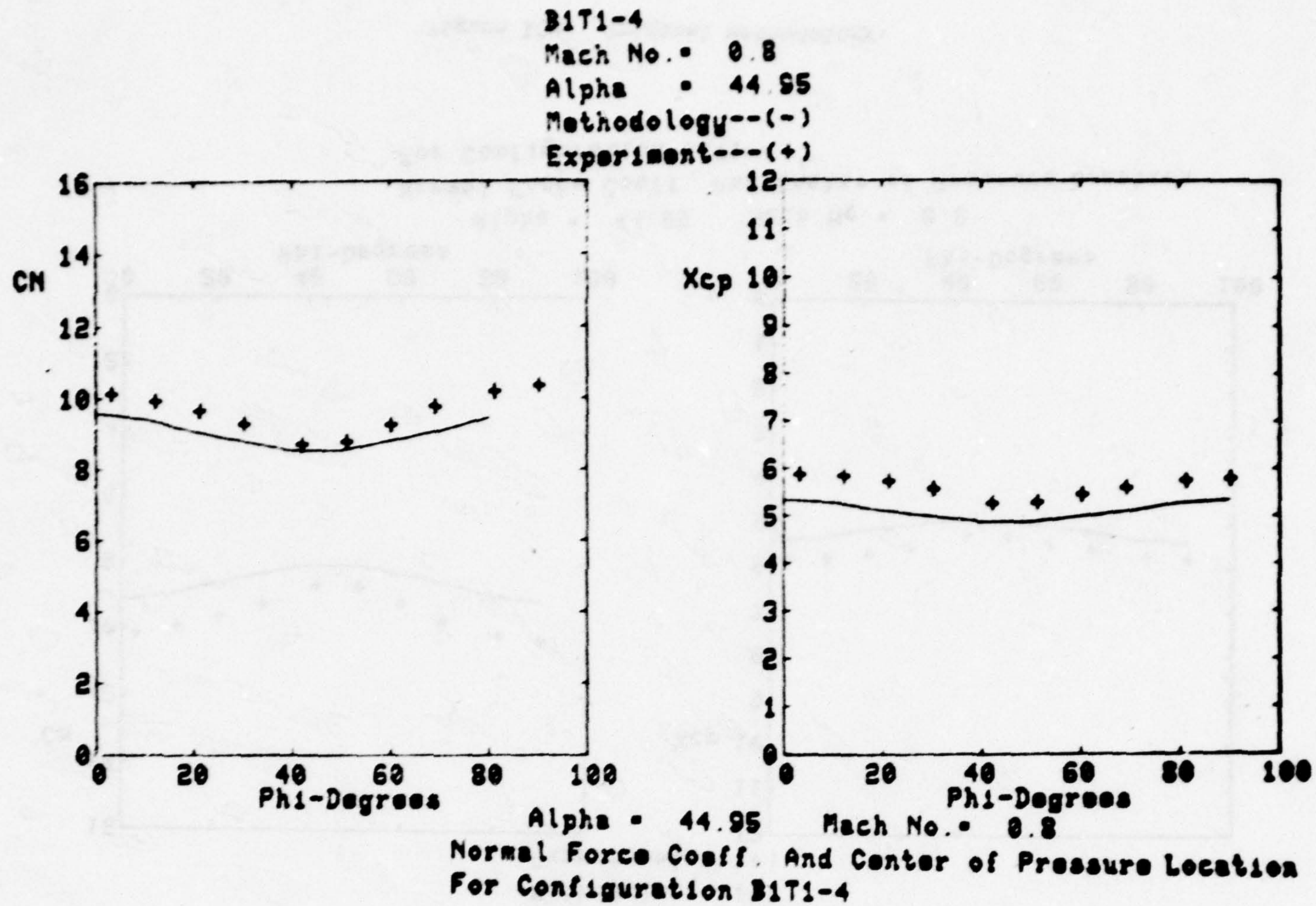


Figure 10b. Modified methodology.

Appendix A. PROGRAM UTILIZATION

The proper format and sequence for the input cards are shown in Table A-1.

TABLE A-1.

CARD	SYMBOL REFERENCE	FORMAT(FORTRAN)
1	Title card for each configuration	12A6
2	AR,S,CR,LAMDA,ALE	5F10.3
3	LND,LAD,D	3F10.3
4	ALF1,ALF2,DELAF,MACH,RN,OPTPHI, OPTMAC	4F10.3,F13.2,2I2

AR = Tail aspect ratio (two tail panels joined at root chord)

S = Tail Semispan including body, (b + D)/2, inches

CR = Tail root chord - Inches

LAMDA = Tail taper ratio

ALE = Tail leading edge sweep angle - Degrees

LND = Nose length - Calibers

LAD = After-body length - Calibers

D = Body diameter - Inches

ALF1 = Beginning angle of attack for angle of attack sweep - Deg.

ALF2 = Ending angle of attack for angle of attack sweep - Deg.

DELAF = Angle of attack increment for alpha sweep - Degrees

MACH = Free stream Mach number

RN = Reynolds number - /Ft.

OPTPHI = 1 to calculate aerodynamic coefficients as a function of roll angle. Roll angle is automatically varied between 0° and 90° in increments of 10°. No additional data cards are required. See Sample Configuration 2 Input Data.

= 0 to delete calculation of aerodynamic coefficients as a function of roll angle

OPTMAC = 1 allows for multiple Mach numbers for the configuration and angle of attack range determined by the four cards Table A-1. Additional Mach numbers are added after the four cards of Table A-1, one Mach number per card using F10.3 Format

= 0 for single Mach number only

MULTIPLE CASE CAPABILITY:

Additional configurations can be input simply by repeating the card sequence of Table A-1.

If OPTMAC = 1, however, a blank card must follow the last Mach number card before the program will accept additional configurations.

Table A-2 shows a sample input card arrangement. Using this input card arrangement the program will predict aerodynamic coefficients for sample configuration No. 1 for Mach No. equal .8 and for angles of attack from 0.0 to 45. degrees in 5 degree increments. Since OPTPHI is 0 for sample configuration No. 1, the coefficients will be given versus angle of attack only (roll angle equals 0 degrees). Now, OPTMAC equals 1, therefore additional predictions will be made for the same configuration and angle of attack range for Mach numbers: .9, 1.0, 1.1, 1.2, and 1.3. A blank card follows the Mach number cards for sample configuration No. 1, which signals the program to read additional configurations.

The program then reads the cards for sample configuration No. 2, and computes the predictions of the aerodynamic coefficients and centers of pressure for this configuration. Now, since OPTPHI equals 1 in this case, these predictions will be given as a function of roll angle, for the angle of attack range 0 to 40 degrees. Also, since OPTMAC equals 0 for this case, the predictions will be made for Mach No. equal 2.0 only.

The resulting output for these sample input cards are found in Table A-3.

As a guide for time and storage requirements, the following figures for the CDC 6600 are provided:

Compile Time	-	14 seconds
Execution Time	-	2 seconds
Storage	-	Less than 100K.

AMSMI-W FORM 22, 1 SEP 71 REPLACES
AMSMI-K FORM 745 WHICH MAY BE USED

FORTRAN - 7090 CODING FORM

TITLE:

TABLE A-2.

CODER:

Identification
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DATE

PAGE OF

C FOR COMMENT

STATEMENT NUMBER | Cont. | FORTRAN STATEMENT

```
 SAMPLE CØNFIGURATIØN  1  ØPTPHI=0,  ØPTMAC=1
1.0       3.75      7.5       0.0       75.964
3.        7.0       3.75
0.0       45.0      5.0       .8        7000000.        .0001
.9
1.0
1.1
1.2
1.3
(BLANK CARD)
 SAMPLE CØNFIGURATIØN  2,  ØPTPHI=1,  ØPTMAC=0
1.0       3.75      5.0       .5        53.13
3.        8.25      3.75
0.0       40.       10.       2.0       6500000.        0100
EØF
```

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TABLE A-3.

```
SAMPLE CONFIGURATION  1  OPTPHI=0, OPTMAC=1
----------------------------------------------------
I          INPUT PARAMETERS                        I
I                                                  I
I           MACH =    .80                          I
I           TAIL ASPECT RATIO =  1.00              I
I           TAIL TAPER RATIO =  0.00               I
I           TAIL L.E. SWEEP ANGLE = 75.96 DEGREES  I
I           TAIL ROOT CHORD=  7.500                I
I           NOSE LENGTH = 3.000 CAL.               I
I           AFTER BODY LENGTH = 7.000 CAL.         I
I           BODY DIAMETER =  3.75                  I
I           TAIL SEMI-SPAN(INCLUDING BODY) = 3.75  I
I           REYNOLDS NUMBER =    7000000.00        I
I                                                  I
----------------------------------------------------

----------------------------------------------------
I          OUTPUT DEFINITIONS                      I
I                                                  I
I  CNB = BODY ALONE NORMAL FORCE COEFFICIENT       I
I  XCPB= BODY ALONE CENTER OF PRESSURE             I
I  CNT = TAIL ALONE NORMAL FORCE COEFFICIENT       I
I  XCPT= TAIL ALONE CENTER OF PRESSURE             I
I  CNT(B)= TAIL(IN PRESENCE OF BODY) NORMAL FORCE  I
I      COEFFICIENT                                 I
I  XCPT(B) = TAIL (IN PRESENCE OF BODY) CHORDWISE  I
I    CENTER OF PRESSURE/TAIL ROOT CHORD (MEASURED  I
I    AFT FROM ROOT CHORD LEADING EDGE)             I
I  YCPT(B) = TAIL (IN PRESENCE OF BODY) SPANWISE   I
I    CENTER OF PRESSURE/TAIL SEMI-SPAN (EXCLUDING  I
I  XCP(B+T)= CENTER OF PRESSURE OF BODY PLUS TAIL  I
I      BODY) MEASURED OUTWARD FROM BODY            I
I    CONFIGURATION (CAL. FROM NOSE)                I
I  CNT(B+T)= NORMAL FORCE COEFFICIENT  OF BODY     I
I    PLUS TAIL CONFIGURATION                       I
I  CA = AXIAL FORCE COEFFICIENT                    I
I                                                  I
----------------------------------------------------
```

ALPHA	ISOLATED COMPONENTS				BODY TAIL CONFIGURATION					
	CNB	XCPB	CNT	XCPT	CNT(B)	XCPT(B)	YCPT(B)	CN(B+T)	XCP(B+T)	CA
0.00	0.000	2.545	0.000	.651	0.000	.651	.335	0.000	I	.286
5.00	.245	2.741	.140	.651	.202	.647	.335	.706	6.932	.278
10.00	.612	3.181	.307	.643	.431	.632	.335	1.541	6.784	.256
15.00	.961	3.649	.494	.632	.660	.618	.335	2.335	6.883	.219
20.00	.888	3.927	.695	.620	.863	.613	.316	2.651	7.394	.169
25.00	1.151	3.927	.906	.616	1.020	.617	.301	3.219	7.281	.141
30.00	1.652	3.927	1.234	.611	1.236	.623	.282	4.081	7.042	.093
35.00	3.695	3.927	1.220	.617	1.219	.630	.282	6.168	6.026	.019
40.00	5.701	3.927	.967	.622	.975	.637	.282	7.908	5.386	-.081
45.00	7.039	3.927	1.213	.628	1.239	.644	.282	9.610	5.331	-.202

```
SAMPLE CONFIGURATION  1  OPTPHI=0, OPTMAC=1

------------------------------------------------------------
I        INPUT PARAMETERS                                  I
I                                                          I
I         MACH =    .90                                    I
I         TAIL ASPECT RATIO =  1.00                        I
I         TAIL TAPER RATIO =  0.00                         I
I         TAIL L.E. SWEEP ANGLE = 75.96 DEGREES            I
I         TAIL ROOT CHORD=  7.500                          I
I         NOSE LENGTH = 3.000 CAL.                         I
I         AFTER BODY LENGTH = 7.000 CAL.                   I
I         BODY DIAMETER =  3.75                            I
I         TAIL SEMI-SPAN(INCLUDING BODY) = 3.75            I
I         REYNOLDS NUMBER =    7000000.00                  I
I                                                          I
------------------------------------------------------------

------------------------------------------------------------
         OUTPUT DEFINITIONS                                I
I                                                          I
I  CNB = BODY ALONE NORMAL FORCE COEFFICIENT               I
I  XCPB= BODY ALONE CENTER OF PRESSURE                     I
I  CNT = TAIL ALONE NORMAL FORCE COEFFICIENT               I
I  XCPT= TAIL ALONE CENTER OF PRESSURE                     I
I  CNT(B)= TAIL(IN PRESENCE OF BODY) NORMAL FORCE          I
I      COEFFICIENT                                         I
I  XCPT(B) = TAIL (IN PRESENCE OF BODY) CHORDWISE          I
I    CENTER OF PRESSURE/TAIL ROOT CHORD (MEASURED          I
I    AFT FROM ROOT CHORD LEADING EDGE)                     I
I  YCPT(B) = TAIL (IN PRESENCE OF BODY) SPANWISE           I
I    CENTER OF PRESSURE/TAIL SEMI-SPAN (EXCLUDING          I
I  XCP(B+T)= CENTER OF PRESSURE OF BODY PLUS TAIL          I
I      BODY) MEASURED OUTWARD FROM BODY                    I
I    CONFIGURATION (CAL. FROM NOSE)                        I
I  CNT(B+T)= NORMAL FORCE COEFFICIENT  OF BODY             I
I    PLUS TAIL CONFIGURATION                               I
I  CA = AXIAL FORCE COEFFICIENT                            I
I                                                          I
------------------------------------------------------------
```

ALPHA	ISOLATED COMPONENTS				BODY TAIL CONFIGURATION					
	CNB	XCPB	CNT	XCPT	CNT(B)	XCPT(B)	YCPT(B)	CN(B+T)	XCP(B+T)	CA
0.00	0.000	2.729	0.000	.651	0.000	.651	.335	0.000	I	.305
5.00	.246	2.880	.143	.651	.207	.648	.335	.708	6.987	.298
10.00	.604	3.223	.311	.644	.436	.633	.335	1.534	6.820	.275
15.00	.894	3.596	.497	.632	.664	.619	.335	2.266	6.956	.238
20.00	.893	3.835	.696	.621	.864	.613	.316	2.650	7.353	.188
25.00	1.195	3.835	.903	.616	1.017	.617	.301	3.254	7.197	.166
30.00	2.782	3.835	1.239	.612	1.241	.624	.282	5.213	6.319	.126
35.00	4.615	3.835	1.192	.618	1.192	.631	.282	7.050	5.675	.065
40.00	6.240	3.835	.993	.623	1.004	.638	.282	8.482	5.242	-.018
45.00	8.114	3.835	1.218	.629	1.253	.644	.282	10.701	5.126	-.120

MPLE CONFIGURATION 1 OPTPHI=0, OPTMAC=1

```
INPUT PARAMETERS

MACH = 1.00
TAIL ASPECT RATIO = 1.00
TAIL TAPER RATIO = 0.00
TAIL L.E. SWEEP ANGLE = 75.96 DEGREES
TAIL ROOT CHORD= 7.500
NOSE LENGTH = 3.000 CAL.
AFTER BODY LENGTH = 7.000 CAL.
BODY DIAMETER = 7.75
TAIL SEMI-SPAN(INCLUDING BODY) = 3.75
REYNOLDS NUMBER = 7000000.00
```

```
OUTPUT DEFINITIONS

CNB = BODY ALONE NORMAL FORCE COEFFICIENT
XCPB= BODY ALONE CENTER OF PRESSURE
CNT = TAIL ALONE NORMAL FORCE COEFFICIENT
XCPT= TAIL ALONE CENTER OF PRESSURE
CNT(B)= TAIL(IN PRESENCE OF BODY) NORMAL FORCE
   COEFFICIENT
XCPT(B) = TAIL (IN PRESENCE OF BODY) CHORDWISE
  CENTER OF PRESSURE/TAIL ROOT CHORD (MEASURED
  AFT FROM ROOT CHORD LEADING EDGE)
YCPT(B) = TAIL (IN PRESENCE OF BODY) SPANWISE
  CENTER OF PRESSURE/TAIL SEMI-SPAN (EXCLUDING
XCP(B+T)= CENTER OF PRESSURE OF BODY PLUS TAIL
    BODY) MEASURED OUTWARD FROM BODY
  CONFIGURATION (CAL. FROM NOSE)
CNT(B+T)= NORMAL FORCE COEFFICIENT  OF BODY
  PLUS TAIL CONFIGURATION
CA = AXIAL FORCE COEFFICIENT
```

	ISOLATED COMPONENTS				BODY TAIL CONFIGURATION					
ALPHA	CNB	XCPB	CNT	XCPT	CNT(B)	XCPT(B)	YCPT(B)	CN(B+T)	XCP(B+T)	CA
.00	0.000	2.969	0.000	.652	0.000	.652	.335	0.000	I	.400
.00	.246	3.056	.149	.652	.214	.649	.335	.724	7.097	.392
.00	.590	3.260	.319	.645	.447	.635	.335	1.544	6.907	.370
.00	.648	3.496	.505	.635	.675	.622	.335	2.046	7.360	.333
0.00	.897	3.679	.703	.624	.873	.617	.316	2.677	7.314	.283
2[illegible].00	1.737	3.806	.907	.620	1.021	.621	.301	3.812	6.716	.265
[illegible]0.00	3.858	3.934	1.269	.616	1.271	.627	.282	6.336	5.980	.234
3[illegible].00	4.930	4.062	1.143	.621	1.144	.633	.282	7.310	5.722	.186
4[illegible].00	7.082	4.190	1.068	.626	1.085	.640	.282	9.431	5.429	.120
[illegible].00	8.995	4.317	1.258	.632	1.309	.646	.282	11.654	5.427	.038

```
AMPLE CONFIGURATION  1  OPTPHI=0. OPTMAC=1
-----------------------------------------------------
   INPUT PARAMETERS                                 I
                                                    I
     MACH =  1.10                                   I
     TAIL ASPECT RATIO =  1.00                      I
     TAIL TAPER RATIO =  0.00                       I
     TAIL L.E. SWEEP ANGLE = 75.96 DEGREES          I
     TAIL ROOT CHORD=  7.500                        I
     NOSE LENGTH = 3.000 CAL.                       I
     AFTER BODY LENGTH = 7.000 CAL.                 I
     BODY DIAMETER =  3.75                          I
     TAIL SEMI-SPAN(INCLUDING BODY) = 3.75          I
     REYNOLDS NUMBER =   7000000.00                 I
                                                    I
-----------------------------------------------------

-----------------------------------------------------
   OUTPUT DEFINITIONS                               I
                                                    I
 CNB = BODY ALONE NORMAL FORCE COEFFICIENT          I
 XCPB= BODY ALONE CENTER OF PRESSURE                I
 CNT = TAIL ALONE NORMAL FORCE COEFFICIENT          I
 XCPT= TAIL ALONE CENTER OF PRESSURE                I
 CNT(B)= TAIL(IN PRESENCE OF BODY) NORMAL FORCE     I
     COEFFICIENT                                    I
 XCPT(B) = TAIL (IN PRESENCE OF BODY) CHORDWISE     I
   CENTER OF PRESSURE/TAIL ROOT CHORD (MEASURED     I
   AFT FROM ROOT CHORD LEADING EDGE)                I
 YCPT(B) = TAIL (IN PRESENCE OF BODY) SPANWISE      I
   CENTER OF PRESSURE/TAIL SEMI-SPAN (EXCLUDING     I
 XCP(B+T)= CENTER OF PRESSURE OF BODY PLUS TAIL     I
     BODY) MEASURED OUTWARD FROM BODY               I
   CONFIGURATION (CAL. FROM NOSE)                   I
 CNT(B+T)= NORMAL FORCE COEFFICIENT  OF BODY        I
   PLUS TAIL CONFIGURATION                          I
 CA = AXIAL FORCE COEFFICIENT                       I
                                                    I
-----------------------------------------------------
```

ALPHA	ISOLATED COMPONENTS CNB	XCPB	CNT	XCPT	BODY TAIL CONFIGURATION CNT(B)	XCPT(B)	YCPT(B)	CN(B+T)	XCP(B+T)	CA
0.00	0.000	2.626	0.000	.654	0.000	.654	.335	0.000	I	.510
5.00	.246	2.788	.146	.654	.211	.651	.335	.722	7.037	.503
0.00	.569	3.157	.313	.647	.438	.638	.335	1.517	6.941	.480
5.00	.643	3.555	.494	.638	.660	.626	.335	2.027	7.411	.443
0.00	.920	3.806	.687	.628	.853	.622	.316	2.679	7.344	.393
5.00	2.351	3.929	.885	.624	.997	.625	.301	4.399	6.378	.380
0.00	3.746	4.043	1.166	.621	1.186	.630	.282	6.121	6.045	.358
5.00	5.437	4.162	1.267	.625	1.261	.636	.282	7.968	5.764	.323
0.00	7.743	4.281	1.322	.630	1.333	.642	.282	10.406	5.542	.273
5.00	9.352	4.399	1.368	.635	1.397	.648	.282	12.124	5.500	.211

```
SAMPLE CONFIGURATION  1  OPTPHI=0, OPTMAC=1
```

INPUT PARAMETERS

```
MACH =  1.20
TAIL ASPECT RATIO =  1.00
TAIL TAPER RATIO =  0.00
TAIL L.E. SWEEP ANGLE = 75.96 DEGREES
TAIL ROOT CHORD=  7.500
NOSE LENGTH = 3.000 CAL.
AFTER BODY LENGTH = 7.000 CAL.
BODY DIAMETER =  3.75
TAIL SEMI-SPAN(INCLUDING BODY) = 3.75
REYNOLDS NUMBER =   7000000.00
```

OUTPUT DEFINITIONS

```
CNB = BODY ALONE NORMAL FORCE COEFFICIENT
XCPB= BODY ALONE CENTER OF PRESSURE
CNT = TAIL ALONE NORMAL FORCE COEFFICIENT
XCPT= TAIL ALONE CENTER OF PRESSURE
CNT(B)= TAIL(IN PRESENCE OF BODY) NORMAL FORCE
   COEFFICIENT
XCPT(B) = TAIL (IN PRESENCE OF BODY) CHORDWISE
  CENTER OF PRESSURE/TAIL ROOT CHORD (MEASURED
  AFT FROM ROOT CHORD LEADING EDGE)
YCPT(B) = TAIL (IN PRESENCE OF BODY) SPANWISE
  CENTER OF PRESSURE/TAIL SEMI-SPAN (EXCLUDING
XCP(B+T)= CENTER OF PRESSURE OF BODY PLUS TAIL
   BODY) MEASURED OUTWARD FROM BODY
  CONFIGURATION (CAL. FROM NOSE)
CNT(B+T)= NORMAL FORCE COEFFICIENT  OF BODY
  PLUS TAIL CONFIGURATION
CA = AXIAL FORCE COEFFICIENT
```

ALPHA	ISOLATED COMPONENTS				BODY TAIL CONFIGURATION					
	CNB	XCPB	CNT	XCPT	CNT(B)	XCPT(B)	YCPT(B)	CN(B+T)	XCP(B+T)	CA
0.00	0.000	2.431	0.000	.655	0.000	.655	.335	0.000	I	.526
5.00	.245	2.665	.144	.655	.207	.652	.335	.721	7.888	.518
10.00	.549	3.191	.307	.649	.431	.641	.335	1.491	7.013	.495
15.00	.645	3.741	.486	.640	.649	.630	.335	2.020	7.474	.459
20.00	1.159	4.051	.674	.632	.837	.626	.316	2.903	7.155	.409
25.00	2.751	4.152	.869	.628	.978	.629	.301	4.780	6.302	.400
30.00	4.082	4.253	1.145	.625	1.147	.634	.282	6.407	6.056	.387
35.00	5.911	4.355	1.255	.629	1.252	.639	.282	8.432	5.810	.364
40.00	8.002	4.456	1.340	.633	1.345	.644	.282	10.682	5.652	.332
45.00	9.299	4.557	1.404	.638	1.420	.649	.282	12.100	5.638	.289

SAMPLE CONFIGURATION 1 OPTPHI=0, OPTMAC=1

```
---------------------------------------------------
I    INPUT PARAMETERS                             I
I                                                 I
I      MACH =  1.30                               I
I      TAIL ASPECT RATIO =  1.00                  I
I      TAIL TAPER RATIO =  0.00                   I
I      TAIL L.E. SWEEP ANGLE = 75.96 DEGREES      I
I      TAIL ROOT CHORD=  7.500                    I
I      NOSE LENGTH = 3.000 CAL.                   I
I      AFTER BODY LENGTH = 7.000 CAL.             I
I      BODY DIAMETER =  3.75                      I
I      TAIL SEMI-SPAN(INCLUDING BODY) = 3.75      I
I      REYNOLDS NUMBER =     7000000.00           I
I                                                 I
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---------------------------------------------------
I    OUTPUT DEFINITIONS                           I
I                                                 I
I CNB = BODY ALONE NORMAL FORCE COEFFICIENT       I
I XCPB= BODY ALONE CENTER OF PRESSURE             I
I CNT = TAIL ALONE NORMAL FORCE COEFFICIENT       I
I XCPT= TAIL ALONE CENTER OF PRESSURE             I
I CNT(B)= TAIL(IN PRESENCE OF BODY) NORMAL FORCE  I
I   COEFFICIENT                                   I
I XCPT(B) = TAIL (IN PRESENCE OF BODY) CHORDWISE  I
I   CENTER OF PRESSURE/TAIL ROOT CHORD (MEASURED  I
I   AFT FROM ROOT CHORD LEADING EDGE)             I
I YCPT(B) = TAIL (IN PRESENCE OF BODY) SPANWISE   I
I   CENTER OF PRESSURE/TAIL SEMI-SPAN (EXCLUDING  I
I XCP(B+T)= CENTER OF PRESSURE OF BODY PLUS TAIL  I
I    BODY) MEASURED OUTWARD FROM BODY             I
I   CONFIGURATION (CAL. FROM NOSE)                I
I CNT(B+T)= NORMAL FORCE COEFFICIENT  OF BODY     I
I   PLUS TAIL CONFIGURATION                       I
I CA = AXIAL FORCE COEFFICIENT                    I
I                                                 I
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ALPHA	ISOLATED COMPONENTS CNB	XCPB	CNT	XCPT	BODY TAIL CONFIGURATION CNT(B)	XCPT(B)	YCPT(B)	CN(B+T)	XCP(B+T)	CA
0.00	0.000	2.242	0.000	.656	0.000	.656	.328	0.000	I	.530
5.00	.245	2.540	.142	.656	.200	.653	.328	.713	6.963	.522
10.00	.529	3.204	.304	.650	.411	.642	.328	1.450	7.052	.499
15.00	.647	3.889	.482	.642	.619	.632	.328	1.989	7.503	.463
20.00	1.491	4.252	.670	.633	.805	.628	.315	3.199	6.913	.413
25.00	2.825	4.339	.865	.630	.954	.631	.302	4.828	6.369	.409
30.00	4.417	4.426	1.115	.627	1.116	.636	.287	6.707	6.067	.405
35.00	6.108	4.512	1.241	.631	1.237	.641	.287	8.613	5.886	.395
40.00	7.536	4.599	1.339	.635	1.341	.646	.287	10.213	5.814	.379
45.00	10.281	4.686	1.414	.639	1.424	.650	.287	13.087	5.661	.356

SAMPLE CONFIGURATION 2, OPTPHI=1, OPTMAC=0

```
INPUT PARAMETERS

MACH = 2.00
TAIL ASPECT RATIO = 1.00
TAIL TAPER RATIO = .50
TAIL L.E. SWEEP ANGLE = 53.13 DEGREES
TAIL ROOT CHORD= 5.000
NOSE LENGTH = 3.000 CAL.
AFTER BODY LENGTH = 8.250 CAL.
BODY DIAMETER = 3.75
TAIL SEMI-SPAN(INCLUDING BODY) = 3.75
REYNOLDS NUMBER = 6500000.00
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OUTPUT DEFINITIONS

CNB = BODY ALONE NORMAL FORCE COEFFICIENT
XCPB= BODY ALONE CENTER OF PRESSURE
CNT = TAIL ALONE NORMAL FORCE COEFFICIENT
XCPT= TAIL ALONE CENTER OF PRESSURE
CNT(B)= TAIL(IN PRESENCE OF BODY) NORMAL FORCE
   COEFFICIENT
XCPT(B) = TAIL (IN PRESENCE OF BODY) CHORDWISE
   CENTER OF PRESSURE/TAIL ROOT CHORD (MEASURED
   AFT FROM ROOT CHORD LEADING EDGE)
YCPT(B) = TAIL (IN PRESENCE OF BODY) SPANWISE
   CENTER OF PRESSURE/TAIL SEMI-SPAN (EXCLUDING
XCP(B+T)= CENTER OF PRESSURE OF BODY PLUS TAIL
     BODY) MEASURED OUTWARD FROM BODY
   CONFIGURATION (CAL. FROM NOSE)
CNT(B+T)= NORMAL FORCE COEFFICIENT OF BODY
   PLUS TAIL CONFIGURATION
CA = AXIAL FORCE COEFFICIENT
```

ALPHA= 0.00

PHI	CNT(B) FIN 2	CNT(B) FIN 4	XCPT(B) FIN 2 UPPER	XCPT(B) FIN 2 LOWER	XCPT(B) FIN 4 UPPER	XCPT(B) FIN 4 LOWER	YCPT(B) FIN 2	YCPT(B) FIN 4	XCP(B+T) UPPER	XCP(B+T) LOWER	CN(B+T)	CA
0.	0.000	0.000	.536	.536	.536	.536	.407	.407			0.000	.343
10.	0.000	0.000	.536	.536	.536	.536	.408	.407			0.000	.343
20.	0.000	0.000	.536	.536	.536	.536	.413	.407			0.000	.343
30.	0.000	0.000	.536	.536	.536	.536	.429	.407			0.000	.343
40.	0.000	0.000	.536	.536	.536	.536	.458	.407			0.000	.343
50.	0.000	0.000	.536	.536	.536	.536	.507	.407			0.000	.343
60.	0.000	0.000	.536	.536	.536	.536	.579	.407			0.000	.343
70.	0.000	0.000	.536	.536	.536	.536	.681	.407			0.000	.343
80.	0.000	0.000	.639	.417	.536	.536	.816	.407			0.000	.343
90.	0.000	0.000	.974	.030	.536	.536	.989	.407			0.000	.343

LPHA= 10.00

PHI	CNT(B) FIN 2	CNT(B) FIN 4	XCPT(B) FIN 2 UPPER	XCPT(B) FIN 2 LOWER	XCPT(B) FIN 4 UPPER	XCPT(B) FIN 4 LOWER	YCPT(B) FIN 2	YCPT(B) FIN 4	XCP(B+T) UPPER	XCP(B+T) LOWER	CN(B+T)	CA
0.	.361	.361	.562	.562	.562	.562	.407	.407	7.196	7.196	.961	.343
10.	.316	.389	.553	.553	.562	.562	.409	.407	7.154	7.154	.950	.343
20.	.258	.397	.557	.553	.561	.561	.426	.407	7.062	7.065	.927	.343
30.	.192	.390	.553	.553	.559	.559	.470	.407	6.985	6.981	.907	.343
40.	.124	.371	.553	.553	.556	.556	.557	.407	6.966	6.962	.902	.343
50.	.063	.326	.619	.507	.552	.552	.699	.407	6.966	6.962	.902	.343
60.	.013	.254	.870	.173	.545	.545	.912	.407	6.985	6.981	.907	.343
70.	-.019	.173	.742	.299	.537	.537	1.000	.407	7.062	7.065	.927	.343
80.	-.025	.088	.549	.522	.536	.536	1.000	.407	7.154	7.154	.950	.343
90.	.000	0.000	.536	.536	.536	.536	1.000	.407	7.196	7.196	.961	.343

LPHA= 20.00

PHI	CNT(B) FIN 2	CNT(B) FIN 4	XCPT(B) FIN 2 UPPER	XCPT(B) FIN 2 LOWER	XCPT(B) FIN 4 UPPER	XCPT(B) FIN 4 LOWER	YCPT(B) FIN 2	YCPT(B) FIN 4	XCP(B+T) UPPER	XCP(B+T) LOWER	CN(B+T)	CA
0.	.682	.682	.583	.583	.583	.583	.407	.407	6.309	6.309	4.115	.343
10.	.560	.766	.572	.572	.582	.582	.411	.407	6.280	6.280	4.088	.343
20.	.419	.788	.572	.572	.581	.581	.442	.407	6.208	6.208	4.023	.343
30.	.272	.776	.572	.572	.578	.578	.527	.407	6.146	6.149	3.970	.343
40.	.132	.756	.667	.471	.575	.575	.690	.407	6.143	6.138	3.964	.343
50.	.012	.684	.957	.066	.571	.571	.960	.407	6.143	6.138	3.964	.343
60.	-.074	.572	.681	.369	.563	.563	1.000	.407	6.146	6.149	3.970	.343
70.	-.114	.364	.536	.535	.554	.554	1.000	.407	6.208	6.208	4.023	.343
80.	-.093	.185	.536	.536	.538	.538	1.000	.407	6.280	6.280	4.088	.343
90.	-.000	0.000	.536	.536	.536	.536	1.000	.407	6.309	6.309	4.115	.343

LPHA= 30.00

PHI	CNT(B) FIN 2	CNT(B) FIN 4	XCPT(B) FIN 2 UPPER	XCPT(B) FIN 2 LOWER	XCPT(B) FIN 4 UPPER	XCPT(B) FIN 4 LOWER	YCPT(B) FIN 2	YCPT(B) FIN 4	XCP(B+T) UPPER	XCP(B+T) LOWER	CN(B+T)	CA
0.	.957	.957	.587	.587	.587	.587	.407	.407	6.065	6.065	8.098	.343
10.	.802	1.109	.584	.584	.587	.587	.410	.407	6.064	6.064	8.097	.343
20.	.621	1.149	.584	.584	.587	.587	.433	.407	6.025	6.026	8.030	.343
30.	.430	1.126	.584	.584	.586	.586	.496	.407	5.990	5.991	7.970	.343
40.	.246	1.091	.603	.573	.585	.585	.617	.407	5.992	5.988	7.970	.343
50.	.085	.986	.776	.327	.587	.583	.817	.407	5.992	5.988	7.970	.343
60.	-.037	.767	.857	.170	.576	.576	1.000	.407	5.990	5.991	7.970	.343
70.	-.102	.524	.566	.477	.565	.565	1.000	.407	6.025	6.026	8.030	.343
80.	-.096	.266	.536	.536	.548	.548	1.000	.407	6.064	6.064	8.097	.343
90.	.000	0.000	.536	.536	.536	.536	1.000	.407	6.065	6.065	8.098	.343

LPHA= 40.00

PHI	CNT(B) FIN 2	CNT(B) FIN 4	XCPT(B) FIN 2 UPPER	XCPT(B) FIN 2 LOWER	XCPT(B) FIN 4 UPPER	XCPT(B) FIN 4 LOWER	YCPT(B) FIN 2	YCPT(B) FIN 4	XCP(B+T) UPPER	XCP(B+T) LOWER	CN(B+T)	CA
0.	1.245	1.245	.592	.592	.592	.592	.407	.407	6.074	6.074	12.217	.343
10.	1.052	1.427	.587	.587	.592	.592	.409	.407	6.074	6.074	12.218	.343
20.	.837	1.474	.587	.587	.591	.591	.424	.407	6.050	6.050	12.156	.343
30.	.616	1.448	.587	.587	.590	.590	.463	.407	6.032	6.031	12.108	.343
40.	.404	1.411	.587	.587	.588	.588	.539	.407	6.040	6.039	12.129	.343
50.	.215	1.281	.615	.574	.587	.587	.665	.407	6.040	6.039	12.129	.343
60.	.065	.996	.797	.303	.565	.565	.854	.407	6.032	6.031	12.108	.343
70.	-.031	.661	.831	.195	.576	.576	1.000	.407	6.050	6.050	12.156	.343
80.	-.058	.346	.577	.499	.557	.557	1.000	.407	6.074	6.074	12.218	.343
90.	-.000	0.000	.536	.536	.536	.536	1.000	.407	6.074	6.074	12.217	.343

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      PROGRAM MAIN(TAPE5,TAPE6)                                          000100
C*********************************************************************000110
C     THIS PROGRAM USES AN AERODYNAMIC METHODOLOGY DEVELOPED BY THE     *000120
C     MARTIN MARIETTA CORP. TO PREDICT AERODYNAMIC COEFFICIENTS OF      *000130
C     MISSILES WITH LOW ASPECT RATIO TAILS AT LOW AND HIGH ANGLES OF    *000140
C     ATTACK AND ARBITRARY ROLL ANGLES.                                 *000150
C                                                                       *000160
C     THE INPUT PARAMETERS AND THIER LIMITS FOR THIS METHOD ARE,        *000170
C                                                                       *000180
C                                                                       *000190
C        MACH   = MACH NUMBER        .8 TO 3.0
C        ALPHA  = ANGLE OF ATTACK (DEG)   0. TO 180 (0 TO 45 FOR ROLL) *000200
C        ALE      = TAIL LEADING EDGE SWEEP ANGLE (DEG)    0 TO 70 DEG  *000210
C        LAD    = AFTER BODY LENGTH IN CAL.    6 TO 18                  *000220
C        LND    = NOSE LENGTH IN CAL.    1.5 TO 3.5                     *000230
C        LAMDA =  TAIL TAPER RATIO  0 TO 1                              *000240
C        AR       = TAIL ASPECT RATIO (TWO PANELS)    .5 TO 3.5         *000250
C        ALF1   = BEGINNING ALPHA FOR DESIRED ALPHA SWEEP (DEG)         *000260
C        ALF2   = END POINT FOR ALPHA SWEEP (DEG)                       *000270
C        DELAF  = ALPHA INCREMENT FOR ALPHA SWEEP (DEG)                 *000280
C        RN     = REYNOLDS NUMBER/FT.                                   *000290
C        S        = TAIL SEMI SPAN INCLUDING BODY,(B+D)/2, INCHES       *000300
C        CR     = TAIL ROOT CHORD  INCHES                               *000310
C        D        = BODY DIAMETER  INCHES                               *000320
C     OPTPHI= 0  GIVES NO PREDICTIONS VS. ROLL ANGLE                    *000330
C                                                                       *000340
C              = 1  GIVES AERODYNAMIC COEFFICIENTS AND CENTER OF        *000350
C                   PRESSURE AS A FUNCTION OF ROLL ANGLE                *000360
C        OPTMAC= 1  ALLOWS FOR MULTIPLE MACH NO. CALCULATIONS FOR       *000370
C                   A GIVEN CONFIGURATIN                                *000380
C                                                                       *000390
C              = 0  CALCULATIONS FOR SINGLE MACH NO. ONLY               *000400
C*********************************************************************000410
      INTEGER OPTPHI,OPTMAC                                              000420
      DIMENSION ANAME(12)                                                000430
      REAL MACH,LAMDA,LND,LAD,IBT                                        000440
      GO TO 11                                                           000450
    1 IF(OPTMAC.EQ. 1) GO TO 2                                           000460
   11 READ(5,208) (ANAME(I),I=1,12)                                      000470
      IF(EOF(5)) 400,25                                                  000480
   25 READ(5,200) AR,S,CR,LAMDA,ALE                                      000490
      READ(5,201) LND,LAD,D                                              000500
   15 READ(5,202) ALF1,ALF2,DELAF,MACH,RN,OPTPHI,OPTMAC                  000510
      GO TO 3                                                            000520
    2 READ(5,203) MACH                                                   000530
      IF(EOF(5))400,26                                                   000540
   26 IF(MACH.EQ. 0.) GO TO 11                                           000550
    3 WRITE(6,140)                                                       000560
      WRITE(6,208) (ANAME(I),I=1,12)                                     000570
      WRITE(6,112)                                                       000580
      WRITE(6,109)                                                       000590
      WRITE(6,110)                                                       000600
      WRITE(6,111) MACH                                                  000610
      WRITE(6,112) AR                                                    000620
      WRITE(6,113) LAMDA                                                 000630
      WRITE(6,114) ALE                                                   000640
      WRITE(6,115) CR                                                    000650
      WRITE(6,116) LND                                                   000660
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      WRITE(6,117) LAD                                                000670
      WRITE(6,150) D                                                  000680
      WRITE(6,151) S                                                  000690
      WRITE(6,118) RN                                                 000700
      WRITE(6,110)                                                    000710
      WRITE(6,119)                                                    000720
      WRITE(6,141)                                                    000730
      WRITE(6,141)                                                    000740
      WRITE(6,119)                                                    000750
      WRITE(6,120)                                                    000760
      WRITE(6,110)                                                    000770
      WRITE(6,121)                                                    000780
      WRITE(6,122)                                                    000790
      WRITE(6,123)                                                    000800
      WRITE(6,124)                                                    000810
      WRITE(6,125)                                                    000820
      WRITE(6,126)                                                    000830
      WRITE(6,127)                                                    000840
      WRITE(6,128)                                                    000850
      WRITE(6,161)                                                    000860
      WRITE(6,129)                                                    000870
      WRITE(6,130)                                                    000880
      WRITE(6,131)                                                    000890
      WRITE(6,162)                                                    000900
      WRITE(6,132)                                                    000910
      WRITE(6,133)                                                    000920
      WRITE(6,134)                                                    000930
      WRITE(6,135)                                                    000940
      WRITE(6,110)                                                    000950
      WRITE(6,119)                                                    000960
    6 PI = 3.1415926535                                               000970
      RAD = PI/180.                                                   000980
      ST = .5*CR*(1.+LAMDA)*(S-D/2.)                                  000990
      SBASE = 3.14159*(D/2.)**2                                       001000
      ARATIO = ST/SBASE                                               001010
      R=LND**2 +.25                                                   001020
      AWETS = ((2.*PI*R)*((R-.5)*ASIN(-LND/R)+LND))*D**2+LAD*D*2.*    001030
     1PI*(D/2.)                                                       001040
      AWOR=AWETS/SBASE                                                001050
      KOUNT = 0                                                       001060
      KIT = 2                                                         001070
      ALPHA = ALF1                                                    001080
      IF(OPTPHI .EQ. 1) GO TO 5                                       001090
    4 WRITE(6,142)                                                    001100
      WRITE(6,106)                                                    001110
      WRITE(6,107)                                                    001120
      WRITE(6,142)                                                    001130
    5 CALL AXIAL(LAD,LND,MACH,AWOR,ALPHA,RN,CA)                       001140
      CALL XCPBTT(ALPHA,LAMDA,MACH,AR,D,S,XCPBT)                      001150
      XCPI = (LND+LAD-CR/D)+ XCPBT*CR/D                               001160
      CALL CNBOD(LAD,LND,MACH,ALPHA,D,CNB,RN)                         001170
      CALL XCPBOD(LAD,LND,D,MACH,ALPHA,XCPB)                          001180
      IF(OPTPHI .EQ. 1) GO TO 10                                      001190
      CALL CNTT(ALPHA,LAMDA,MACH,AR,CNT)                              001200
      CALL XCPTT(ALPHA,LAMDA,MACH,AR,XCPT)                            001210
      IF(ALPHA .GT.45.) GO TO 300                                     001220
      PHI = 90.                                                       001230
```

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```
      CALL CNTPHI(MACH,AR,LAMDA,D,S,ALPHA,PHI,CR,ALE,CN)
      CALL IBTT(LAMDA,MACH,AR,ALPHA,PHI,S,D,IBT)
      CALL XCPTBB(MACH,AR,LAMDA,D,S,CR,ALPHA,PHI,XCPTB1,XCPTB2)
      CALL YCPTS(LAMDA,PHI,ALPHA,MACH,S,D,CR,YCPT)
      CNBT = CNB + 2.*CNTB*ARATIO + IBT
      XXCPTI = LAD+LND-CR/D + XCPTB1*CR/D
      GO TO 16
  300 WRITE(6,204) ALPHA,CNB,XCPB,CNT,XCPT,CA
      GO TO 30
   16 XCPBT = (CNB*XCPB + 2.*CNTB*ARATIO*XXCPTI      + IBT*XCPI)/CNBT
      WRITE(6,108) ALPHA,CNB,XCPB,CNT,XCPT,CNTB,XCPTB1,YCPT,CNBT,XCPBT,
     1CA
   30 ALPHA = ALPHA + DELAF
      IF(ALPHA .GT. ALF2) GO TO 1
      KOUNT = KOUNT + 1
      IF(KOUNT .EQ. 50 .AND. OPTPHI .EQ. 0) GO TO 4
      GO TO 5
   10 IF(KIT .EQ. 0) WRITE(6,140)
      WRITE(6,141)
      WRITE(6,101) ALPHA
      WRITE(6,105)
      WRITE(6,102)
      WRITE(6,103)
      WRITE(6,104)
      WRITE(6,105)
      KIT = KIT + 1
      IF(KIT.EQ. 3) KIT = 0
      PHI = 0.
      DO 20 I=1,10
      PHI1 = 180. - PHI
      PHI2 = PHI + 90.
      PHI3 = PHI
      PHI4 = 90.- PHI
      CALL CNTPHI(MACH,AR,LAMDA,D,S,ALPHA,PHI1,CR,ALE,CNTB1)
      CALL CNTPHI(MACH,AR,LAMDA,D,S,ALPHA,PHI2,CR,ALE,CNTB2)
      CALL CNTPHI(MACH,AR,LAMDA,D,S,ALPHA,PHI3,CR,ALE,CNTB3)
      CALL CNTPHI(MACH,AR,LAMDA,D,S,ALPHA,PHI4,CR,ALE,CNTB4)
      CALL XCPTBB(MACH,AR,LAMDA,D,S,CR,ALPHA,PHI1,XCPTU1,XCPTL1)
      CALL XCPTBB(MACH,AR,LAMDA,D,S,CR,ALPHA,PHI2,XCPTU2,XCPTL2)
      CALL XCPTBB(MACH,AR,LAMDA,D,S,CR,ALPHA,PHI3,XCPTU3,XCPTL3)
      CALL XCPTBB(MACH,AR,LAMDA,D,S,CR,ALPHA,PHI4,XCPTU4,XCPTL4)
      CALL YCPTS(LAMDA,PHI1,ALPHA,MACH,S,D,CR,YCPT1)
      CALL YCPTS(LAMDA,PHI2,ALPHA,MACH,S,D,CR,YCPT2)
      CALL YCPTS(LAMDA,PHI3,ALPHA,MACH,S,D,CR,YCPT3)
      CALL YCPTS(LAMDA,PHI4,ALPHA,MACH,S,D,CR,YCPT4)
      CALL IBTT(LAMDA,MACH,AR,ALPHA,PHI,S,D,IBT)
      IF(ALPHA.GT. 90.) GO TO 35
      XCTL1=LAD+LND-CR/D + XCPTL1*CR/D
      XCTL2=LAD+LND-CR/D + XCPTL2*CR/D
      XCTL3=LAD+LND-CR/D + XCPTL3*CR/D
      XCTL4=LAD+LND-CR/D + XCPTL4*CR/D
      XCTU1=LAD+LND-CR/D + XCPTU1*CR/D
      XCTU2=LAD+LND-CR/D + XCPTU2*CR/D
      XCTU3=LAD+LND-CR/D + XCPTU3*CR/D
      XCTU4=LAD+LND-CR/D + XCPTU4*CR/D
      GO TO 36
   35 XCTL1=LAD+LND-XCPTL1*CR/D
```

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      XCTL2=LAD+LND-XCPTL2*CR/D                                         001810
      XCTL3=LAD+LND-XCPTL3*CR/D                                         001820
      XCTL4=LAD+LND-XCPTL4*CR/D                                         001830
      XCTU1=LAD+LND-XCPTU1*CR/D                                         001840
      XCTU2=LAD+LND-XCPTU2*CR/D                                         001850
      XCTU3=LAD+LND-XCPTU3*CR/D                                         001860
      XCTU4=LAD+LND-XCPTU4*CR/D                                         001870
   36 P = PHI*RAD                                                       001880
      CNBT = CNB + (CNTB1*SIN(P) + CNTB2*COS(P) + CNTB3*SIN(P) + CNTB4* 001890
     1COS(P))*ARATIO + IBT                                              001900
      XCPBTU = (CNB*XCPB + (CNTB1*XCTU1 *SIN(P) + CNTB2*XCTU2 *COS(P)   001910
     1+CNTB3*XCTU3 *SIN(P) + CNTB4*XCTU4 *COS(P))*ARATIO     +IBT*XCPI) 001920
     2/CNBT                                                             001930
      XCPBTL = (CNB*XCPB + (CNTB1*XCTL1 *SIN(P) + CNTB2*XCTL2 *COS(P)   001940
     1+CNTB3*XCTL3 *SIN(P) + CNTB4*XCTL4 *COS(P))*ARATIO     +IBT*XCPI) 001950
     2/CNBT                                                             001960
      WRITE(6,100) PHI,CNTB2,CNTB4,XCPTU2,XCPTL2,XCPTU4,XCPTL4,YCPT2,   001970
     1YCPT4,XCPBTU,XCPBTL,CNBT,CA                                       001980
      PHI = PHI + 10.                                                   001990
   20 CONTINUE                                                          002000
      PHI = 0.                                                          002010
      GO TO 30                                                          002020
  102 FORMAT (1H ,*I  PHI  I     CNT(B)     I              XCPT(B)      002030
     1   I    YCPT(B)     I     XCP(B+T)     I    CN(B+T)     I  CA   I*002040
     1)                                                                 002050
  103 FORMAT(1H ,*I         I FIN 2 I FIN 4 I     FIN 2     I     FIN 4 002060
     1  I FIN 2 I FIN 4 I  UPPER  I  LOWER  I               I       I*)002070
  104 FORMAT(1H ,*I        I        I         I UPPER I LOWER I UPPER I LOWE002080
     1R I       I       I        I         I                I       I*)002090
  105 FORMAT(1H ,*------------------------------------------------------002100
     1------------------------------------------------------------*)002110
  100 FORMAT(1H ,2X,F4.0,   8F8.3,F9.3,1X,F9.3,5X,F8.3,5X,F8.3)         002120
  101 FORMAT(1H ,*ALPHA=*F6.2)                                          002130
  108 FORMAT(1H , F6.2,3X,F7.3,2X,F7.3,2X,F7.3,2X,F7.3,2X,F7.3,2X,F8.3,2002140
     1X,F7.3,3X,F9.3,3X,F10.3,3X,F7.3)                                  002150
  106 FORMAT(1H ,*I ALPHA I          ISOLATED COMPONENTS          I     002160
     1        BODY TAIL CONFIGURATION                       I*)         002170
  107 FORMAT(1H ,*I        I   CNB  I  XCPB  I   CNT  I  XCPT  I CNT(B) I002180
     1 XCPT(B) I YCPT(B) I  CN(B+T)  I  XCP(B+T)  I   CA   I*)          002190
  142 FORMAT(1H ,*------------------------------------------------------002200
     1----------------------------------------------------*)            002210
  109 FORMAT(1H ,*I          INPUT PARAMETERS                        I*)002220
  110 FORMAT(1H ,*I                                                  I*)002230
  111 FORMAT(1H ,*I          MACH = *,F5.2,*                            002240
     1I*)                                                               002250
  112 FORMAT(1H ,*I          TAIL ASPECT RATIO = *,F5.2,*               002260
     1I*)                                                               002270
  113 FORMAT(1H ,*I          TAIL TAPER RATIO = *,F5.2,*                002280
     1I*)                                                               002290
  114 FORMAT(1H ,*I          TAIL L.E. SWEEP ANGLE = *,F5.2,* DEGREES   002300
     1I*)                                                               002310
  115 FORMAT(1H ,*I          TAIL ROOT CHORD= *,F6.3,*                 I002320
     1*)                                                                002330
  116 FORMAT(1H ,*I          NOSE LENGTH =*F6.3,* CAL.                 I 002340
     1*)                                                                002350
  117 FORMAT(1H ,*I          AFTER BODY LENGTH =*,F6.3,* CAL.          I002360
     1*)                                                                002370
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  150 FORMAT(1H ,*I          BODY DIAMETER = *,F5.2,*                       002380
     1I*)                                                                   002390
  151 FORMAT(1H ,*I          TAIL SEMI-SPAN(INCLUDING BODY) =*,F5.2,*       002400
     1I*)                                                                   002410
  118 FORMAT(1H ,*I          REYNOLDS NUMBER =*,F13.2,*           I*)       002420
  119 FORMAT(1H ,*-------------------------------------------------------*)002430
  120 FORMAT(1H ,*I          OUTPUT DEFINITIONS                       I*)002440
  121 FORMAT(1H ,*I  CNB = BODY ALONE NORMAL FORCE COEFFICIENT         I*)002450
  122 FORMAT(1H ,*I  XCPB= BODY ALONE CENTER OF PRESSURE               I*)002460
  123 FORMAT(1H ,*I  CNT = TAIL ALONE NORMAL FORCE COEFFICIENT         I*)002470
  124 FORMAT(1H ,*I  XCPT= TAIL ALONE CENTER OF PRESSURE               I*)002480
  125 FORMAT(1H ,*I  CNT(B)= TAIL(IN PRESENCE OF BODY) NORMAL FORCE    I*)002490
  126 FORMAT(1H ,*I      COEFFICIENT                                   I*)002500
  127 FORMAT(1H ,*I  XCPT(B) = TAIL (IN PRESENCE OF BODY) CHORDWISE    I*)002510
  128 FORMAT(1H ,*I    CENTER OF PRESSURE/TAIL ROOT CHORD (MEASURED    I*)002520
  161 FORMAT(1H ,*I    AFT FROM ROOT CHORD LEADING EDGE)               I*)002530
  129 FORMAT(1H ,*I  YCPT(B) = TAIL (IN PRESENCE OF BODY) SPANWISE     I*)002540
  130 FORMAT(1H ,*I    CENTER OF PRESSURE/TAIL SEMI-SPAN (EXCLUDING    I*)002550
  162 FORMAT(1H ,*I      BODY) MEASURED OUTWARD FROM BODY              I*)002560
  131 FORMAT(1H ,*I  XCP(B+T)= CENTER OF PRESSURE OF BODY PLUS TAIL    I*)002570
  132 FORMAT(1H ,*I    CONFIGURATION (CAL. FROM NOSE)                  I*)002580
  133 FORMAT(1H ,*I  CNT(B+T)= NORMAL FORCE COEFFICIENT  OF BODY       I*)002590
  134 FORMAT(1H ,*I    PLUS TAIL CONFIGURATION                         I*)002600
  135 FORMAT(1H ,*I  CA = AXIAL FORCE COEFFICIENT                      I*)002610
  140 FORMAT(1H1)                                                          002620
  141 FORMAT(1H0)                                                          002630
  200 FORMAT(5F10.3)                                                       002640
  201 FORMAT(3F10.3)                                                       002650
  202 FORMAT(4F10.3,F13.2,I2,I2)                                           002660
  203 FORMAT(F10.2)                                                        002670
  205 FORMAT(11F6.3)                                                       002680
  206 FORMAT(4F10.3)                                                       002690
  207 FORMAT(I5,F6.3)                                                      002700
  208 FORMAT(12A6)                                                         002710
  204 FORMAT(1H ,F6.2,3X,F7.3,2X,F7.3,2X,F7.3,2X,F7.3,2X,* ----- *,2X,    002720
     1* ---- *,2X,* ---- *,3X,* ----- *,3X,* ----- *,3X,F7.2)              002730
  400 STOP                                                                 002740
      END                                                                  002750
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      SUBROUTINE CNTPHI(MACH,AR,LAMDA,D,S,ALPHA,PHI,CR,ALE,CNTP)         002760
C*********************************************************************002770
C                                                                      *002780
C     THIS SUBROUTINE CALCULATES TAIL NORMAL FORCE COEFFICIENT IN      *002790
C     PRESENCE OF CYLINDRICAL BODY AS A FUNCTION OF ROLL ANGLE         *002800
C                                                                      *002810
C        MACH      = MACH NUMBER                                       *002820
C        AR        = ASPECT RATIO                                      *002830
C        LAMDA     = TAIL TAPER RATIO                                  *002840
C        D         = BODY DIAMETER                                     *002850
C        S         = TAIL SEMI-SPAN (INCLUDING BODY)                   *002860
C        ALPHA     = ANGLE OF ATTACK (DEGREES)                         *002870
C        PHI       = ROLL ANGLE (DEGREES)                              *002880
C        CR        = ROOT CHORD LENGTH                                 *002890
C        ALE       = LEADING EDGE ANGLE (DEGREES)                      *002900
C        CNTP = TAIL NORMAL FORCE COEFF.  IN PRESENTS OF CYLIN. BODY   *002910
C                                                                      *002920
C*********************************************************************002930
      REAL LAMDA,MACH,MACHTP,KTP,KTBT,KTBDS                             002940
      DIMENSION RTBPCT(3,3),RTHPAR(3),RTBPLD(3),                        002950
     .          RPRMT(19,10,3),RPRMM(19),RPRMA(10),RPRMLM(3),           002960
     .          RTRTT(19,10,2),RTRTM(19),RTRTA(10),RTRTAR(2),           002970
     .          KTBT(11),KTBDS(11),                                     002980
     .          RTBP2T(12,3),RTBP2M(12),RTBP2L(3),                      002990
     .          PHIPT(6),PHIPAT(6),                                     003000
     .          BET(9,9,3),BEALFT(9),BEALET(9),BEMACT(3),               003010
     .          RTBPGT(14,3),RTBPGA(14),RTBPGM(3),                      003020
     .          RTBPAT(3,3),                                            003030
     .          BBT(5,8,4),BBALFT(5),BBALET(8),BBMACT(4)                003040
      DATA (RPRMM(I),I=1,19)/1.2,1.3,1.4,1.5,1.6,1.7,1.8,1.9,2.0,2.1,   003050
     12.2,2.3,2.4,2.5,2.6,2.7,2.8,2.9,3.0/                              003060
      DATA (RPRMA(I),I=1,10)/0.,5.,10.,15.,20.,25.,30.,35.,40.,45./     003070
      DATA ((RPRMT(I,J,1),I=1,19),J=1,10)/0.,0.,0.,0.,0.,0.,0.,0.,0.,0.,003080
     10.,0.,0.,0.,0.,0.,0.,0.,0.,-0.41,-.11,-.257,-.496,-.612,-.629,    003090
     2-.633,-.637,-.641,-.645,-.649,-.649,-.649,-.653,-.653,-.653,-.657,003100
     3-.661,0.,-.052,-.169,-.507,-.836,-.954,-.974,-.979,-.979,-.979,   003110
     4-.983,-.987,-.983,-.983,-.983,-.983,-.983,-.983,-.987,0.,-.057,   003120
     5-.208,-.653,-1.,-1.069,-1.086,-1.09,-1.082,-1.073,-1.061,-1.045,  003130
     6-1.029,-1.012,-.988,-.963,-.939,-.914,-.89,0.,-.057,-.204,-.657,  003140
     7-1.008,-1.073,-1.09,-1.086,-1.086,-1.073,-1.057,-1.037,-1.016,    003150
     8-.988,-.959,-.927,-.894,-.861,-.824,0.,-.053,-.171,-.51,-.98,-1., 003160
     9-1.,-1.,-1.,-.996,-.984,-.967,-.947,-.927,-.906,-.882,-.853,-.829,003170
     *-.808,0.,-.053,-.163,-.441,-.751,-.845,-.861,-.861,-.861,-.861,   003180
     1-.857,-.853,-.849,-.841,-.837,-.833,-.824,-.816,-.808,0.,-.057,   003190
     2-.167,-.416,-.71,-.804,-.812,-.812,-.812,-.812,-.812,-.816,-.82,  003200
     3-.824,-.824,-.833,-.837,-.849,-.857,0.,-.045,-.147,-.371,-.669,   003210
     4-.763,-.78,-.784,-.784,-.788,-.792,-.796,-.804,-.816,-.829,-.849, 003220
     5-.878,-.906,-.935,0.,-.045,-.127,-.343,-.629,-.735,-.751,-.751,   003230
     6-.751,-.755,-.767,-.78,-.796,-.816,-.841,-.878,-.922,-.971,-1.037/003240
      DATA ((RPRMT(I,J,2),I=1,19),J=1,10)/0.,0.,0.,0.,0.,0.,0.,0.,0.,0.,003250
     10.,0.,0.,0.,0.,0.,0.,0.,0.,-.037,-.139,-.302,-.4,-.445,-.461,     003260
     2-.469,-.478,-.482,-.49,-.494,-.498,-.502,-.506,-.506,-.510,-.510, 003270
     3-.514,0.,-.037,-.167,-.42,-.559,-.624,-.641,-.641,-.641,-.641,    003280
     4-.645,-.649,-.657,-.673,-.69,-.714,-.735,-.776,-.82,0.,-.041,     003290
     5-.196,-.531,-.739,-.82,-.833,-.837,-.837,-.833,-.824,-.816,-.804, 003300
     6-.792,-.78,-.763,-.747,-.739,-.722,0.,-.045,-.204,-.571,-.816,    003310
     7-.91,-.931,-.931,-.931,-.922,-.91,-.89,-.869,-.845,-.816,-.784,   003320
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     8-.751,-.722,-.69,0.,-.045,-.204,-.571,-.816,-.91,-.931,-.931,        003330
     9-.931,-.922,-.910,-.89,-.869,-.845,-.816,-.784,-.751,-.722,-.69,     003340
     *0.,-.041,-.184,-.527,-.714,-.792,-.812,-.812,-.812,-.812,-.808,      003350
     1-.808,-.804,-.8,-.796,-.788,-.784,-.776,-.771,0.,-.041,-.196,        003360
     2-.539,-.767,-.849,-.861,-.861,-.857,-.857,-.857,-.853,-.853,-.849,003370
     3-.849,-.849,-.849,-.849,-.853,0.,-.041,-.176,-.49,-.714,-.792,       003380
     4-.808,-.812,-.812,-.812,-.808,-.808,-.804,-.8,-.816,-.841,-.865,     003390
     5-.898,-.939,0.,-.041,-.167,-.457,-.645,-.727,-.747,-.743,-.743,      003400
     6-.747,-.755,-.767,-.788,-.808,-.837,-.869,-.914,-.967,-1.037/        003410
      DATA ((RPRMT(I,J,7),I=1,19),J=1,10)/0.,0.,0.,0.,0.,0.,0.,0.,0.,0.,003420
     10.,0.,0.,0.,0.,0.,0.,0.,0.,0.,-.033,-.127,-.286,-.38,-.437,-.457,    003430
     2-.465,-.469,-.469,-.465,-.457,-.449,-.433,-.416,-.4,-.384,-.363,     003440
     3-.343,0.,-.029,-.127,-.282,-.38,-.424,-.441,-.441,-.441,-.441,       003450
     4-.445,-.449,-.457,-.469,-.486,-.502,-.522,-.555,-.596,0.,-.037,      003460
     5-.151,-.343,-.469,-.527,-.539,-.539,-.539,-.539,-.543,-.543,-.543,003470
     6-.551,-.555,-.559,-.567,-.576,-.584,0.,-.037,-.151,-.437,-.616,      003480
     7-.694,-.71,-.71,-.71,-.702,-.698,-.686,-.682,-.673,-.661,-.649,      003490
     8-.637,-.629,-.616,0.,-.037,-.155,-.494,-.747,-.833,-.853,-.857,      003500
     9-.853,-.849,-.837,-.829,-.808,-.788,-.767,-.747,-.727,-.702,-.678,003510
     *0.,-.037,-.151,-.498,-.747,-.837,-.853,-.857,-.857,-.849,-.845,      003520
     1-.837,-.829,-.816,-.804,-.792,-.776,-.763,-.751,0.,-.037,-.155,      003530
     2-.473,-.698,-.78,-.796,-.796,-.8,-.8,-.8,-.804,-.808,-.812,-.812,    003540
     3-.82,-.824,-.829,-.837,0.,-.037,-.159,-.469,-.669,-.751,-.763,       003550
     4-.763,-.763,-.767,-.771,-.776,-.788,-.8,-.816,-.837,-.857,-.894,     003560
     5-.927,0.,-.033,-.151,-.449,-.641,-.722,-.739,-.739,-.743,-.743,      003570
     6-.751,-.763,-.78,-.804,-.833,-.865,-.902,-.959,-1.02/                003580
      DATA (RPRMLM(I),I=1,3)/0.,.5,1./                                     003590
      DATA(RTRTAR(I),I=1,2)/.5,2./                                         003600
      DATA (RTRTA(I),I=1,10)/0.,5.,10.,15.,20.,25.,30.,35.,40.,45./        003610
      DATA (RTRTM(I),I=1,19)/1.2,1.3,1.4,1.5,1.6,1.7,1.8,1.9,2.,2.1,2.2,003620
     12.3,2.4,2.5,2.6,2.7,2.8,2.9,3./                                      003630
      DATA ((RTRTT(I,J,1),I=1,19),J=1,10)/1.,1.,1.,1.,1.,1.,1.,1.,1.,1.,003640
     11.,1.,1.,1.,1.,1.,1.,1.,1.,1.,1.,1.,1.,1.,1.,1.,1.,1.,1.,1.,1.,     003650
     21.,1.,1.,1.,1.,1.,1.,1.,1.,1.,1.,1.,1.,1.,1.,1.,1.,1.,1.,1.,1.,     003660
     31.,1.,1.,1.,1.,1.,1.,1.,1.,1.,1.,1.,1.,1.,1.,1.,1.,1.,1.,1.,1.,     003670
     41.,1.,.989,.976,.966,.961,.959,.959,.959,.961,                       003680
     5.964,.966,.971,.976,.981,.989,.994,.999,.999,1.,.996,.976,.941,      003690
     6.902,.889,.884,.884,.884,.889,.897,.904,.917,.931,.946,.966,.981,    003700
     7.991,.999,1.,.996,.976,.941,.902,.889,.884,.884,.884,.889,.897,      003710
     8.904,.917,.931,.946,.966,.981,.991,.999,1.,.989,.951,.892,.849,      003720
     9.824,.814,.812,.817,.827,.839,.857,.882,.907,.931,.956,.974,.989,    003730
     *1.,1.,.984,.924,.842,.762,.727,.712,.71,.715,.727,.745,.767,.792,    003740
     1.824,.845,.877,.897,.909,.914,1.,.984,.926,.824,.687,.617,.6,.598,003750
     2.607,.625,.655,.69,.722,.757,.782,.802,.822,.834,.844/               003760
      DATA ((RTRTT(I,J,2),I=1,19),J=1,10)/0.,0.,0.,0.,0.,0.,0.,0.,0.,0.,003770
     10.,0.,0.,0.,0.,0.,0.,0.,0.,0.,0.,0.,0.,0.,0.,0.,0.,0.,0.,0.,0.,     003780
     20.,0.,0.,0.,0.,0.,1.,.989,.969,.924,.894,.879,.872,.869,.872,.877,003790
     3.887,.899,.912,.929,.951,.969,.981,.989,.996,1.,.979,.929,.822,      003800
     4.752,.715,.7,.697,.705,.722,.74,.767,.797,.839,.884,.919,.949,       003810
     5.976,.996,1.,.981,.939,.857,.787,.745,.73,.727,.735,.75,.769,.797,003820
     6.827,.867,.904,.936,.961,.979,1.,.999,.981,.939,.857,.787,.745,      003830
     7.73,.727,.735,.75,.769,.797,.827,.867,.904,.936,.961,.979,1.,1.,     003840
     8.984,.959,.912,.872,.852,.842,.842,.844,.849,.859,.872,.889,.909,    003850
     9.934,.959,.974,.986,1.,1.,.994,.984,.971,.956,.949,.946,.944,.946,003860
     *.949,.954,.959,.964,.971,.979,.986,.994,1.,1.,1.,1.001,1.016,        003870
     11.059,1.088,1.106,1.111,1.111,1.106,1.098,1.088,1.076,1.056,1.041,003880
     21.024,1.009,1.001,.999,.996,1.,1.019,1.041,1.138,1.223,1.268,        003890
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     31.283,1.285,1.278,1.258,1.233,1.203,1.163,1.118,1.071,1.044,1.024,003900
     41.004,.909/                                                       003910
      DATA (PHIPAT(I),I=1,6)/20.,25.,30.,35.,40.,45./                   003920
      DATA (PHIFT(I),I=1,6)/45.,41.,37.75,35.5,33.,31.5/                003930
      DATA(RTPPGA(I),I=1,14)/20.,22.,24.,26.,28.,30.,32.,34.,36.,38.,40.003940
     *,42.,44.,45./                                                     003950
      DATA (RTBPAM(I),I=1,3)/.8,1.,1.2/                                 003960
      DATA (BPKACT(I),I=1,4)/1.75,2.,2.5,3./                            003970
      DATA (FFMACT(I),I=1,3)/.8,1.,1.2/                                 003980
      DATA ((RTPPCT(I,J),I=1,3),J=1,3)/1.79,1.74,1.58,1.6,1.56,1.37,1.56003990
     *,1.53,1.36/                                                       004000
      DATA (RTPPAM(I),I=1,3)/.5,1.0,2.0/                                004010
      DATA (RTBPLD(I),I=1,3)/0.,.5,1.0/                                 004020
      DATA ((RTPPAT(I,J),I=1,3),J=1,3)/1.798,1.7,1.619,1.7,1.599,1.498,1004030
     *.558,1.452,1.339/                                                 004040
      DATA ((RTPPCT(I,J),I=1,14),J=1,3)/1.549,1.697,1.841,1.954,2.036,2.004050
     *113,2.179,2.241,2.297,2.349,2.4,2.446,2.487,2.503,1.523,1.59,1.677004060
     *,1.754,1.826,1.892,1.954,2.021,2.082,2.138,2.2,2.256,2.313,2.338,1004070
     *.504,1.579,1.651,1.718,1.764,1.81,1.846,1.882,1.913,1.944,1.969,1.004080
     *99,2.005,2.015/                                                   004090
      DATA (((BET(I,J,K),I=1,5),J=1,8),K=1,4)/-.015,.039,.113,.098,.029,004100
     *-.039,.103,.147,.132,.025,-.029,.098,.162,.142,.064,-.025,.088,.15004110
     *7,.167,.123,-.01,.078,.172,.162,.113,.015,.093,.137,.167,.152,.015004120
     *,.123,.176,.167,.157,.054,.186,.216,.216,.211,-.025,.015,.074,.132004130
     *,.103,-.029,.044,.103,.147,.123,.015,.064,.113,.162,.147,.039,.074004140
     *,.142,.186,.098,.054,.098,.142,.191,.172,.049,.103,.157,.211,.172,004150
     *.059,.137,.167,.176,.186,.108,.191,.206,.201,.245,-.034,-.005,.039004160
     *,.127,.181,.001,.064,.123,.186,.225,.025,.069,.142,.206,.23,.034,.004170
     *078,.142,.196,.245,.029,.088,.142,.196,.245,.044,.093,.137,.191,.2004180
     *7,.024,.088,.127,.157,.196,.005,.162,.176,.181,.211,-.034,.010,.08004190
     *3,.137,.186,-.034,.059,.132,.162,.196,.010,.078,.167,.196,.216,.02004200
     *,.113,.181,.206,.221,.015,.132,.186,.225,.255,.034,.152,.167,.230,004210
     *.26,.059,.127,.132,.191,.245,.044,.172,.191,.196,.211/            004220
      DATA (BBALFT(I),I=1,5)/0.,10.,20.,30.,45./                        004230
      DATA (HBALET(I),I=1,8)/0.,10.,20.,30.,40.,50.,60.,70./            004240
      DATA (((HET(I,J,K),I=1,9),J=1,9),K=1,2)/.005,.074,.028,-.041,-.046004250
     *,-.038,-.023,-.005,.005,.010,.030,.023,-.036,-.053,-.048,-.041,-.0004260
     *36,-.033,.008,.01,-.005,-.043,-.074,-.066,-.056,-.051,-.051,.008,-004270
     *.003,-.023,-.079,-.091,-.074,-.063,-.056,-.053,.005,.005,-.041,-.1004280
     *02,-.117,-.089,-.063,-.048,-.033,.005,.018,-.038,-.119,-.15,-.112,004290
     *-.063,-.03,.003,.008,.015,-.079,-.137,-.145,-.124,-.071,-.015,.02,004300
     *.005,.109,.112,.046,-.058,-.048,-.02,.018,.033,.008,.162,.195,.096004310
     *,.02,-.015,.018,.038,.043,.008,-.005,-.023,-.051,-.066,-.071,-.066004320
     *,-.056,-.043,.008,0.0,-.018,-.053,-.109,-.112,-.107,-.091,-.074,.0004330
     *1,.01,-.013,-.081,-.15,-.14,-.129,-.117,-.107,.008,.03,.013,-.094,004340
     *-.185,-.183,-.152,-.124,-.104,0.0,.018,.008,-.071,-.173,-.185,-.15004350
     *5,-.135,-.117,.013,.036,.025,-.033,-.175,-.178,-.142 .117,-.094,.004360
     *005,.056,.048,-.023,-.137,-.170,-.142,-.086,-.063,.023,.124,.14,.1004370
     *09,.071,.051,.043,.041,.043,.003,.162,.195,.168,.114,.094,.086,.08004380
     *1,.081/                                                           004390
      DATA ((BET(I,J,3),I=1,9),J=1,9)/.003,.089,.076,.013,-.03,-.041,-.0004400
     *36,-.018,-.008,.013,.048,.051,-.008,-.074,-.076,-.056,-.041,-.028,004410
     *.005,.033,.033,-.038,-.074,-.091,-.086,-.058,-.041,.010,.038,.03,-004420
     *.036,-.061,-.114,-.102,-.071,-.048,.003,.058,.036,.005,-.051,-.091004430
     *,-.094,-.071,-.056,.005,.091,.084,.056,-.008,-.053,-.053,-.051,-.0004440
     *41,.005,.124,.15,.14,.099,.048,0.0,-.03,-.038,.013,.137,.17,.168,.004450
     *046,.02,.03,.036,.038,0.0,.19,.213,.203,.117,.094,.094,.084,.069/ 004460
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      DATA(BEALFT(I),I=1,9)/0.,10.,15.,20.,25.,30.,35.,40.,45./
      DATA(BEALET(I),I=1,9)/0.,10.,20.,30.,40.,50.,60.,70.,80./
      DATA (KTPT(I),I=1,11)/1.,1.075,1.155,1.25,1.35,1.455,1.55,1.66,
     *1.77,1.88,1.995/
      DATA (KTBCS(I),I=1,11)/0.,.1,.2,.3,.4,.5,.6,.7,.8,.9,1./
      DATA ((RTBP2T(I,J),I=1,12),J=1,3)/1.205,1.221,1.253,1.288,1.343,
     *1.253,1.205,1.181,1.122,1.051,1.031,1.027,1.707,1.731,1.754,1.798,
     *1.857,1.75,1.703,1.675,1.64,1.66,1.707,1.743,2.205,2.225,2.256,
     *2.292,2.355,2.244,2.197,2.173,2.138,2.157,2.201,2.244/
      DATA (RTBP2M(I),I=1,12)/.6,.7,.8,.9,1.,1.1,1.2,1.3,1.5,2.,2.5,3./
      DATA (RTBP2L(I),I=1,3)/0.,.5,1./
      IFLAG = 0
      JFLAG=0
      KFLAG=0
      LFLAG = 0
      DS=D/(2.*S)
      RAD = .0174532925
      PI = 3.14159265
      IF(.8 .LE. MACH .AND.1.2 .GE. MACH) GO TO 200
      IF(1.75 .LE. MACH .AND.3.0 .GE. MACH) GO TO 220
      IF(1.2 .LT. MACH .AND.1.75 .GT. MACH) GO TO 250
      GO TO 26
   25 CONTINUE
      IF(PHI.GT. 90.) GO TO 600
      IF(.8 .LE. MACH .AND. 1.2 .GE. MACH) GO TO 30
      IF(1.75 .LE. MACH .AND.3.0 .GE. MACH) GO TO 40
      IF(1.2 .LT. MACH .AND.1.75 .GT. MACH) GO TO 50
   26 WRITE(6,500)
  500 FORMAT(*ERROR    MACH OUTSIDE ALLOWABLE LIMITS*)
      STOP
   30 IF(ALPHA .GT. 20.) GO TO 60
      CALL LOOK2(RTBP,RTBPCT,3,AR,RTBPAR,3,LAMDA,RTBPLD,3,IX,IY,1)
      IF(PHI.LT. 45.) GO TO 70
      RTB45 = RTBP*SIN(.7853981)
      A = RTB45-RTBO
      CALL LOOK3(B ,BET,9,9,ALPHA,BEALFT,9,ALE,BEALET,9,MACH,BEMACT,3,
     *IX,IY,IZ,1)
      PHIP = 45.
      PHIPRM = 90.-PHI
      PPRIM = 90.- PHIP
      A3=(160000.*PHIPRM-16000.*PHIPRM**2+400.*PHIPRM**3)/(400.*(400.*
     *PPRIM-40.*(PPRIM**2)+PPRIM**3))
      A4= (40.*(PPRIM**3)*PHIPRM-1200.*PHIPRM*(PPRIM**2)-(PPRIM**3)*(
     *PHIPRM**2)+1200.*PPRIM*(PHIPRM**2)+(PPRIM**2)*(PHIPRM**3)-40.*
     *PPRIM*(PHIPRM**3))/(400.*(400.*PPRIM-40.*(PPRIM**2)+PPRIM**3))
      RTB = RTBO + A*A3 + B *A4
      GO TO 80
   70 RTB = RTBP*SIN(PHI*.0174532)
   80 IF(JFLAG .EQ. 1) GO TO 90
      IF(KFLAG .EQ. 1) GO TO 100
  110 CONTINUE
      CALL CNTT(ALPHA,LAMDA,MACH,AR,CNT)
      CNTP = RTB*CNT
      RETURN
   60 CALL LOOK2(RTBP,RTBPGT,14,ALPHA,RTBPGA,14,MACH,RTBPGM,3,IX,IY,1)
      CALL LOOK1(PHIP,PHIPT,ALPHA,PHIPAT,6,IX,1)
      IF(PHI .LT. PHIP) GO TO 140
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      PHIPRM = 90.-PHI
      PPRIM = 90.- PHIP
      A3=(160000.*PHIPRM-16000.*PHIPRM**2+400.*PHIPRM**3)/(400.*(400.*
     *PPRIM-40.*(PPRIM**2)+PPRIM**3))
      A4= (40.*(PPRIM**3)*PHIPRM-1200.*PHIPRM*(PPRIM**2)-(PPRIM**3)*/
     *PHIPRM**2)+1200.*PPRIM*(PHIPRM**2)+(PPRIM**2)*(PHIPRM**3)-40.*
     *PPRIM*(PHIPRM**3))/(400.*(400.*PPRIM-40.*(PPRIM**2)+PPRIM**3))
      RTBPHP = RTBP*SIN(PHIP*.0174532)
      A = RTBPHP-RTBO
      CALL LOOK3(B ,BET,9,9,ALPHA,BEALFT,9,ALE,BEALET,9,MACH,BEMACT,3,
     *IX,IY,IZ,1)
      RTB = RTBO + A*A3 + B *A4
      GO TO 80
  140 RTB = RTBP*SIN(PHI*.0174532)
      GO TO 80
   90 JFLAG = 0
      RTB1 = RTB
      MACH = 1.75
      KFLAG - 1
      GO TO 40
   50 JFLAG = 1
      MACHTP = MACH
      MACH = 1.2
      GO TO 30
  100 KFLAG = 0
      MACH = MACHTP
      RTB2 = RTB
      RTB = RTB1 +((MACH-1.2)/.55)*(RTB2-RTB1)
      GO TO 110
   40 CALL LOOK2(RTBP,RTBPAT,3,AR,RTBPAR,3,LAMDA,RTBPLD,3,IX,IY,1)
      IF(PHI .LT. 45.) GO TO 120
      RTB45 = RTBP*SIN(45.*.0174532)
      A = RTB45-RTBO
      CALL LOOK3(B ,BBT,5,8,ALPHA,BBALFT,5,ALE,BBALET,8,MACH,BBMACT,4,I
     *X,IY,IZ,1)
      PHIP = 45.
      PHIPRM = 90.-PHI
      PPRIM = 90.- PHIP
      A3=(160000.*PHIPRM-16000.*PHIPRM**2+400.*PHIPRM**3)/(400.*(400.*
     *PPRIM-40.*(PPRIM**2)+PPRIM**3))
      A4= (40.*(PPRIM**3)*PHIPRM-1200.*PHIPRM*(PPRIM**2)-(PPRIM**3)*(
     *PHIPRM**2)+1200.*PPRIM*(PHIPRM**2)+(PPRIM**2)*(PHIPRM**3)-40.*
     *PPRIM*(PHIPRM**3))/(400.*(400.*PPRIM-40.*(PPRIM**2)+PPRIM**3))
      RTB = RTBO + A*A3 + B *A4
      GO TO 80
  120 RTB = RTBP*SIN(PHI*.0174532)
      GO TO 80
  200 IF(ALPHA .GT. 30.) GO TO 210
      ALF = ALPHA + 10.
      A0=-2.07752E-07*ALF**4 + 1.72193E-05*ALF**3 + 6.24467E-04*ALF**2
     * -.016456069*ALF + .087604485
      A1 = 4.69769E-07*ALF**4 - 4.22299E-05*ALF**3 + 2.32986E-04*ALF**2
     * +3.6936E-03*ALF + .9815985A5
      CALL LOOK1(KTF,KTFT,DS,KTBDS,11,IX,1)
      RTBO = A0 + A1*KTB
      IF(IFLAG .EQ. 1) GO TO 290
      IF(LFLAG .EQ. 1) GO TO 300
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      GO TO 25
  210 ALF = ALPHA + 10.
      A0 = 4.57998E-12*ALF**6 - 2.30809E-09*ALF**5 + 3.96812E-07*ALF**4
     * -2.15272E-05*ALF**3 - 8.10606E-04*ALF**2 + .092902183*ALF
     * -.838353092
      A1 = 1.67133E-11*ALF**6 - 9.5912E-09*ALF**5 + 2.09288E-06*ALF**4
     * -2.19478E-04*ALF**3 + .011664495*ALF**2 - .303221946*ALF
     * + 3.06745046
  225 CALL LOOK1(KTB,KTBT,DS,KTBDS,11,IX,1)
      A2= -2.16611E-11*ALF**6 + 1.21153E-08*ALF**5 - 2.53877E-06*ALF**4
     * +2.46417E-04*ALF**3 - .01114855*ALF**2 + .217380211*ALF
     * -1.282772555
      CALL LOOK2(RTBP2,RTBP2T,12,MACH,RTBP2M,12,LAMDA,RTBP2L,3,IX,IY,1)
      RTBP2 = RTBP2-LAMDA
      RTBO = A0 + A1*KTB + A2*RTBP2
      IF(LFLAG.EQ. 1) GO TO 300
      IF(IFLAG.EQ.1) GO TO 290
      GO TO 25
  220 ALF = ALPHA + 10.
      A0 = 4.57998E-12*ALF**6 - 2.30809E-09*ALF**5 + 3.96812E-07*ALF**4
     * -2.15272E-05*ALF**3 - 8.10606E-04*ALF**2 + .092902183*ALF
     * -.838353092
      A1 = 1.67133E-11*ALF**6 - 9.5912E-09*ALF**5 + 2.09288E-06*ALF**4
     * -2.19478E-04*ALF**3 + .011664495*ALF**2 - .303221946*ALF
     * + 3.06745046
      GO TO 225
  250 IFLAG = 1
      MACHTP = MACH
      MACH = 1.2
      GO TO 200
  290 IFLAG = 0
      RTBO1 = RTBO
      MACH = 1.75
      LFLAG = 1
      GO TO 220
  300 LFLAG = 0
      MACH = MACHTP
      RTBO2 = RTBO
      RTBO = RTBO1+((MACH-1.2)/.55)*(RTBO2-RTBO1)
      GO TO 25
  600 DCR = D/CR
      CALL PHCC(ALPHA,MACH,DCR,PHC1)
      PHC = PHC1*RAD
      PHI =(PHI-90.)*RAD
      A = (1.-(1./(PHC**2)+(1./PHC-PHC/(PI/2.)**2)/(PI/2.-PHC))*PHI**2
     * +((1./(PHC**2)-1./(PI/2.)**2)/(PI/2.-PHC))*PHI**3)
      B = (PHI-(1./PHC+(1.-PHC/(PI/2.))/(PI/2.-PHC))*PHI**2+((1./PHC
     * -1./(PI/2.))/(PI/2.-PHC))*PHI**3)
      PHI = PHI/RAD+90.
      IF(MACH.LT.1.2) GO TO 610
      CALL LOOK3(RPRM,RPRMT,19,10,MACH,RPRMM,19,ALPHA,RPRMA,10,LAMDA,
     *RPRMLM,3,IX,IY,IZ,1)
      IF(AR.EQ.1.) GO TO 620
      CALL LOOK3(RTRT,RTRTT,19,10,MACH,RTRTM,19,ALPHA,RTRTA,10,AR,
     *RTRTAR,2,IX,IY,IZ,1)
      RPRM = RPRM*RTRT
      GO TO 620
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      610 RPRM = 0.                                                    006180
      620 RTE = RTED*A + RPRM*B                                        006190
          GO TO 310                                                    006200
          END                                                          006210
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      SUBROUTINE CNTT(ALPHA,LAMDA,MACH,AR,CNT)                            006220
C*********************************************************************006230
C                                                                      *006240
C     THIS SUBROUTINE CALCULATES TAIL NORMAL FORCE COEFFICIENT  OF     *006250
C     AN ISOLATED TAIL                                                 *006260
C                                                                      *006270
C         ALPHA      = ANGLE OF ATTACK (DEGREES)                       *006280
C         LAMDA      = TAIL TAPER RATIO                                *006290
C         MACH       = MACH NUMBER                                     *006300
C         AR         = ASPECT RATIO                                    *006310
C         CNT        = TAIL NORMAL FORCE COEFFICIENT  (ISOLATED TAIL)  *006320
C                                                                      *006330
C*********************************************************************006340
      REAL LAMDA,MACH                                                     006350
      DIMENSION FPI2T(25,3,3),FPIMAC(25),FPIAR(3),FPILAM(3),              006360
     *          APRIMT(5,3),APRLAM(5),APRAR(3),                           006370
     $          DCNTAT(11),SCALM(9),CNCMAT(23),                           006380
     *          DCDCT(6,3,3),ADIFT(6),DCDLAM(3),DCDMAC(3),                006390
     *          DCNMT(7,3),CNMLAM(7),CNMAR(3),                            006400
     *          F30T(19,3,3),F30MT(19),F30ART(3),F30LMT(3),               006410
     *          FP30T(19,3,3),FP3MT(19),FP3ART(3),                        006420
     *          CNCT(23),DCNTT(11),SCALET(5)                              006430
      DATA (((DCDCT(I,J,K),I=1,6),J=1,3),K=1,3)/.0,.15,.34,.42,.45,.48,0006440
     *.,.3,.61,.59,.5,.49,0.,.6,1.,.72,.62,.49,0.,.21,.39,.46,.64,.63,0.006450
     *,.25,.48,.59,.63,.7,0.,.46,.85,.95,.99,1.,0.,.15,.35,.47,.53,.65,0006460
     *.,.24,.48,.5,.67,.79,0.,.52,.79,.9,.94,1./                          006470
      DATA(ADIFT(I),I=1,6)/.0,.2,.5,.7,.8,1./                             006480
      DATA(DCDLAM(I),I=1,3)/.0,.5,1./                                     006490
      DATA(DCDMAC(I),I=1,3)/.8,.9,1./                                     006500
      DATA ((DCNMT(I,J),I=1,7),J=1,3)/0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.006510
     *0,.225,.265,.29,.25,.14,0.0,0.0,.11,.32,.465,.465,.42/              006520
      DATA (CNMLAM(I),I=1,7)/0.,.1,.2,.3,.5,.75,1.0/                      006530
      DATA (CNMAR(I),I=1,3)/.5,1.0,2.0/                                   006540
      DATA ((APRIMT(I,J),I=1,5),J=1,3)/30.,30.,30.,30.,30.,30.,21.,19.,2006550
     *0.,21.,23.,13.,11.,11.,11./                                         006560
      DATA (APRLAM(I),I=1,5)/0.,.25,.5,.75,1.0/                           006570
      DATA (APRAR(I),I=1,3)/.5,1.0,2.0/                                   006580
      DATA (DCNTT(I),I=1,11)/0.0,.035,.059,.077,.091,.1,-.026,-.084,-.11006590
     *8,-.14,-.153/                                                       006600
      DATA(DCNTAT(I),I=1,11)/30.,31.,32.,33.,34.,35.,36.,37.,38.,39.,40.006610
     */                                                                   006620
      DATA(SCALET(I),I=1,9)/1.,.98,.932,.868,.788,.7,.584,.452,.296/      006630
      DATA(SCALM(I),I=1,9)/.8,.825,.85,.875,.9,.925,.95,.975,1./          006640
      DATA (((FPI2T(I,J,K),I=1,25),J=1,3),K=1,2)/2.348,2.348,2.348,2.34800665
     *,2.323,2.273,2.197,2.172,2.121,2.071,2.045,2.02,1.995,1.995,1.944,006660
     *1.919,1.869,1.818,1.793,1.768,1.717,1.667,1.641,1.616,1.591,2.727,006670
     *2.727,2.727,2.677,2.626,2.551,2.5,2.5,2.525,2.5,2.399,2.273,2.121,006680
     *2.045,1.97,1.894,1.843,1.818,1.742,1.742,1.692,1.667,1.641,1.591,1006690
     *.591,3.46,3.46,3.434,3.384,3.283,3.131,2.854,2.955,3.005,3.005,2.8006700
     *79,2.576,2.298,2.071,1.97,1.894,1.869,1.818,1.742,1.717,1.692,1.64006710
     *1,1.616,1.591,1.566,2.98,2.98,3.056,3.207,3.182,3.005,2.929,2.879,006720
     *2.828,2.803,2.727,2.626,2.5,2.348,2.222,2.121,2.045,1.97,1.894,1.8006730
     *18,1.793,1.768,1.768,1.717,1.742,3.46,3.434,3.46,3.864,4.015,3.914006740
     *,3.712,3.409,3.182,3.005,2.879,2.702,2.525,2.374,2.247,2.146,2.02,006750
     *1.894,1.818,1.768,1.742,1.717,1.692,1.667,1.667,2.955,2.955,2.98,3006760
     *.106,5.051,4.116,3.611,3.283,3.03,2.854,2.727,2.576,2.475,2.348,2.006770
     *247,2.146,2.071,1.995,1.944,1.869,1.843,1.818,1.793,1.793,1.793/  006780
```

```
      DATA ((FPI2T(I,J,3),I=1,25),J=1,3)/3.005,2.98,2.98,2.98,3.207,3.05006790
     *6,2.955,2.854,2.753,2.652,2.525,2.424,2.323,2.222,2.121,2.071,1.99006800
     *5,1.919,1.843,1.818,1.793,1.742,1.717,1.692,1.667,2.727,2.753,2.80006810
     *3,2.98,3.561,3.535,3.308,3.056,2.904,2.753,2.601,2.5,2.374,2.298,2006820
     *.222,2.121,2.071,1.995,1.944,1.919,1.894,1.869,1.818,1.818,1.818,1006830
     *.894,1.97,2.323,3.081,3.662,3.333,3.03,2.753,2.601,2.424,2.323,2.2006840
     *47,2.172,2.096,2.045,2.02,1.944,1.919,1.869,1.843,1.818,1.793,1.76006850
                                                                        006860
     *8,1.742,1.742/
      DATA (FPIMAC(I),I=1,25)/.6,.7,.8,.9,1.,1.1,1.2,1.3,1.4,1.5,1.6,1.7006870
     *,1.8,1.9,2.0,2.1,2.2,2.3,2.4,2.5,2.6,2.7,2.8,2.9,3.0/              006880
      DATA (FPIAR(I),I=1,3)/.5,1.0,2.0/                                 006890
      DATA (FPILAM(I),I=1,3)/0.0,.5,1.0/                                006900
      DATA (((FP30T(I,J,K),I=1,19),J=1,3),K=1,3)/0.,0.,0.,.579,.981,1.20006910
     *8,1.409,1.535,1.610,1.736,1.761,1.811,1.686,1.61,1.56,1.535,1.56,1006920
     *.56,1.585,0.,0.,0.,.579,.981,1.208,1.409,1.535,1.610,1.736,1.761,1006930
     *.811,1.686,1.610,1.56,1.535,1.56,1.56,1.585,.0,.0,.0,.403,.755,1.0006940
     *57,1.308,1.535,1.736,1.862,1.91 ,1.836,1.711,1.61,1.585,1.535,1.56006950
     *,1.585,1.61,1.233,.604,.101,.553,.931,1.258,1.409,1.585,1.736,1.86006960
     *2,1.937,2.013,2.063,2.088,2.063,2.013,1.962,1.887,1.811,1.233,.604006970
     *,.075,.704,1.157,1.434,1.585,1.711,1.836,1.937,1.987,2.038,2.038,2006980
     *.063,2.038,1.987,1.962,1.887,1.786,1.233,.629,.075,.403,.805,1.283006990
     *,1.736,2.189,2.138,2.088,2.013,1.937,1.862,1.786,1.761,1.761,1.761007000
     *,1.761,1.786,2.541,1.233,0.,1.434,2.013,2.314,2.39,2.365,2.289,2.1007010
     *89,2.113,1.962,1.862,1.811,1.736,1.736,1.711,1.711,1.736,.654,.352007020
     *,.0,1.409,1.962,1.711,1.61,1.585,1.585,1.66,1.761,1.987,1.862,1.81007030
     *1,1.736,1.711,1.686,1.711,1.736,1.082,.579,0.0,1.384,2.013,2.365,2007040
     *.465,2.465,2.365,2.239,2.138,2.013,1.887,1.811,1.761,1.736,1.711,1007050
                                                                        007060
     *.736,1.736/
      DATA (FP3MT(I),I=1,19)/.8,.9,1.,1.05,1.1,1.15,1.2,1.25,1.3,1.35,1.007070
                                                                        007080
     *4,1.5,1.6,1.7,1.8,1.9,2.,2.1,2.2/
                                                                        007090
      DATA(FP3ART(I),I=1,3)/.5,1.,2./
      DATA(((F30T(I,J,K),I=1,19),J=1,3),K=1,3)/.969,.971,.971,.971,.969,007100
     *.964,.961,.954,.948,.933,.918,.898,.873,.855,.837,.817,.805,.789,.007110
     *777,1.234,1.234,1.239,1.252,1.269,1.214,1.186,1.666,1.145,1.115,1.007120
     *1,1.067,1.019,.971,.928,.901,.88,.87,.868,1.198,1.193,1.198,1.231,007130
     *1.274,1.353,1.443,1.401,1.373,1.342,1.317,1.282,1.236,1.198,1.153,007140
     *1.118,1.09,1.072,1.06,1.098,1.123,1.123,1.116,1.095,1.073,1.047,1.007150
     *025,1.002,.972,.959,.952,.921,.896,.871,.851,.83,.818,.81,.936,.95007160
     *9,1.015,1.108,1.242,1.267,1.265,1.249,1.224,1.174,1.128,1.093,1.05007170
     *8,1.027,1.002,.977,.959,.941,.929,.994,.936,.954,1.065,1.202,1.356007180
     *,1.527,1.52,1.52,1.53,1.406,1.313,1.239,1.176,1.118,1.07,1.047,1.0007190
     *37,1.035,1.146,1.126,1.108,1.093,1.08,1.07,1.065,1.058,1.058,1.06,007200
     *1.027,.984,.949,.916,.891,.866,.848,.835,.823,.835,.858,.898,1.053007210
     *,1.184,1.227,1.224,1.207,1.191,1.171,1.159,1.123,1.063,1.015,.974,007220
     *.946,.926,.911,.904,.868,.891,.931,1.055,1.199,1.353,1.520,1.558,1007230
     *.54,1.424,1.24,1.27,1.214,1.169,1.133,1.106,1.083,1.065,1.05/     007240
      DATA (F30MT(I),I=1,19)/.8,.85,.9,.95,1.,1.05,1.1,1.15,1.2,1.3,1.4,007250
                                                                        007260
     *1.5,1.6,1.7,1.8,1.9,2.0,2.1,2.2/
                                                                        007270
      DATA (F30ART(I),I=1,3)/.5,1.,2./
                                                                        007280
      DATA (F30LMT(I),I=1,3)/.0,.5,1./
      DATA(CNCT(I),I=1,23)/1.1,1.102,1.196,1.423,1.476,1.509,1.535,1.555007290
     *,1.572,1.588,1.6,1.61,1.623,1.631,1.643,1.651,1.661,1.669,1.676,1.007300
                                                                        007310
     *684,1.691,1.696,1.701/
      DATA(CNCMAT(I),I=1,23)/.8,.9,1.,1.1,1.2,1.3,1.4,1.5,1.6,1.7,1.8,1.007320
                                                                        007330
     *9,2.0,2.1,2.2,2.3,2.4,2.5,2.6,2.7,2.8,2.9,3.0/
                                                                        007340
      RAD = .01745329
                                                                        007350
      J = 0
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      K = 0
      ASW = ATAN((2.*(1.-LAMDA))/(AR*(1.+LAMDA)))*57.295779
      CALL BRIT(MACH,AR,LAMDA,ASW,FPRIMO,XCPCB)
      IF(ALPHA .GT. 90.) GO TO 200
    5 IF(ALPHA .GE. 30.) GO TO 10
   70 CALL LOOK3(FPI2,FPI2T,25,3,MACH,FPIMAC,25,AR,FPIAR,3,LAMDA,FPILAM
     *,5,IX,IY,IZ,1)
      IF(MACH .GT. 1.) GO TO 20
   30 CONTINUE
      CALL LOOK2(APRIM,APRIMT,5,LAMDA,APRLAM,5,AR,APRAR,3,IX,IY,1)
      IF(ALPHA .LT. APRIM .OR. APRIM .EQ. 30.) GO TO 20
      ADIF = (ALPHA-APRIM)/(30.-APRIM)
      CALL LOOK3(DCDC,DCDCT,6,3,ADIF,ADIFT,6,LAMDA,DCDLAM,3,MACH,DCDMAC
     *,3,IX,IY,IZ,1)
      CALL LOOK2(DCNM,DCNMT,7,LAMDA,CNMLAM,7,AR,CNMAR,3,IX,IY,1)
      DCN = DCDC*DCNM
      GO TO 50
   20 DCN= 0.
   50 CONTINUE
      CNT= FPRIMO*ALPHA*RAD+(16.*FPI2/3.14156**2 - 5.*FPRIMO/3.14156)*
     * (ALPHA*RAD)**2 + (8.*FPRIMO/3.14156**2 - 32.*FPI2/3.14156**3)*
     * (ALPHA*RAD)**3 + (16.*FPI2/3.14156**4 - 4.*FPRIMO/3.14156**3)*
     * (ALPHA*RAD)**4
      CNT = CNT + DCN
   90 IF(K.EQ.1) GO TO 60
      IF(J.EQ.1) GO TO 210
      RETURN
   10 IF(MACH .GE. 2.5) GO TO 70
  110 IF(LAMDA .EQ. 0. .AND. AR .EQ. 1. .AND. MACH .LE. 1.) GO TO 80
  111 CALL LOOK3(F30,F30T,19,3,MACH,F30MT,19,AR,F30ART,3,LAMDA,F30LMT,
     *3,IX,IY,IZ,1)
      CALL LOOK3(FP30,FP30T,19,3,MACH,FP3MT,19,AR,FP3ART,3,LAMDA,F30LMT,
     *3,IX,IY,IZ,1)
      CALL LOOK1(CNC,CNCT,MACH,CNCMAT,23,IX,1)
      CNT = -1.178111*FP30 + CNC  + (3.7501*FP30-4.29731*(CNC-F30))*
     *(ALPHA*RAD)+(-3.742356*FP30+5.471487*(CNC-F30))*(ALPHA*RAD)**2
     *+(.911921*FP30-1.741626*(CNC-F30))*(ALPHA*RAD)**3
      GO TO 90
   80 IF(30. .LT. ALPHA .AND.40. .GE. ALPHA) GO TO 100
      GO TO 111
  100 K=1
      ATEMP = ALPHA
      ALPHA = 30.
      GO TO 30
   60 K=0
      ALPHA = ATEMP
      CALL LOOK1(DCNT,DCNTT,ALPHA,DCNTAT,11,IX,1)
      CALL LOOK1(SCALE,SCALET,MACH,SCALM,9,IX,1)
      DCNT = DCNT*SCALE
      CNT = CNT + DCNT
      GO TO 90
  200 ATEMP2= ALPHA
      J=1
      ALPHA = 180.-ALPHA
      GO TO 5
  210 ALPHA = ATEMP2
      J=0
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      GO TO 90                                                          007930
      END                                                               007940
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      SUBROUTINE BRIT (XM,AR,TR,SWEEP,CLA,XCPCB)                        007950
C     TAKEN FROM THE BRITISH DATA SHEETS  S.01.03.06                    007960
C                                         S.01.03.05                    007970
C                                         S.01.03.04                    007980
C                                         S.01.03.03                    007990
C                                         S.08.01.02                    008000
C                                                                       008010
C     XM    = FREE STREAM MACH NO.                                      008010
C     AR    = ASPECT RATIO (TWO WINGS JOINED WITHOUT BODY)              008020
C     TR    = TAPER RATIO                                               008030
C     SWEEP = WING MID-CHORD SWEEPBACK ANGLE (DEG)                      008040
C     CLA   = LIFT COEFF. SLOPE, BASED ON EXPOSED WING AREA  1/RAD.     008050
C     XCPCB = CENTER OF PRESSURE (PERCENT MEAN GEOMETERIC CHORD),       008060
C             MEASURED FROM LEADING EDGE MEAN GEOMETERIC CHORD.         008070
      DIMENSION XT1(15),YT1(7),ZT1(4),XT2(8),YT2(5),ZT2(4),YT4(7)       008080
      DIMENSION BAR1(15,7,4), BAR2(8,5,4),BAR3(15,7,4),BAR4(8,7,4)      008090
      DATA XT1/0.,.5,1.,1.5,2.,2.5,3.,3.5,4.,4.5,5.,5.5,6.,6.5,7./      008100
      DATA YT1/0.,1.,2.,3.,4.,5.,6./                                    008110
      DATA ZT1/0.,.25,.5,1./                                            008120
      DATA XT2/0.,1.,2.,3.,4.,5.,6.,7./                                 008130
      DATA YT2/0.,1.,2.,3.,4./                                          008140
      DATA YT4/0.,1.,2.,3.,4.,5.,6./                                    008150
      DATA ZT2/0.,.25,.5,1./                                            008160
      DATA(BAR1(I), I=1,210 )                                           008170
     A                    /1.56,1.52,1.41,1.30,1.20,1.11,1.03,.95,.89,.83, 008180
     1.78,.74,.70,.66,.63,1.56,1.52,1.40,1.27,1.17,1.08,1.00,.93,.87,   008190
     2.82,.77,.73,.69,.65,.62,1.56,1.47,1.30,1.17,1.08,1.01,.95,.89,.84,008200
     3.79,.75,.71,.67,.64,.61,1.26,1.21,1.13,1.05,.99,.93,.88,.83,.79,  008210
     4.75,.71,.68,.65,.62,.59,1.05,1.01,.98,.94,.89,.85,.81,.77,.73,.7, 008220
     5.67,.64,.61,.59,.57,.90,.88,.86,.83,.80,.77,.74,.71,.68,.66,.63,  008230
     6.61,.59,.57,.55,.79,.78,.77,.75,.73,.70,.68,.65,.63,.61,.59,.57,  008240
     7.55,.53,.52,1.57,1.53,1.45,1.34,1.25,1.16,1.07,1.,.93,.875,.82,.78008250
     8,.735,.695,.66,1.57,1.53,1.42,1.31,1.20,1.11,1.03,.97,.91,.86,.81,008260
     9.765,.72,.685,.65,1.57,1.45,1.31,1.205,1.12,1.05,.98,.925,.87,.82,008270
     1.78,.74,.70,.665,.63,1.26,1.19,1.12,1.06,1.00,.95,.90,.85,.81,.77,008280
     2.74,.70,.67,.64,.61,1.05,1.00,.96,.92,.885,.86,.83,.79,.76,.725,  008290
     3.69,.665,.64,.61,.59,.90,.855,.82,.80,.78,.76,.74,.72,.70,.67,.64,008300
     4.62,.60,.57,.55,.79,.75,.73,.71,.70,.68,.67,.65,.64,.62,.60,.58,  008310
     5.56,.55,.53/                                                      008320
      DATA(BAR1(I),I=211,420   )                                        008330
     A                    /1.58,1.53,1.45,1.35,1.25,1.16,1.07,1.00,.93,.88, 008340
     1.82,.78,.73,.69,.66,1.58,1.52,1.42,1.31,1.21,1.12,1.04,.98,.915,  008350
     2.86,.805,.76,.72,.68,.64,1.58,1.44,1.32,1.20,1.12,1.05,.98,.92,   008360
     3.87,.82,.78,.74,.70,.76,.63,1.26,1.20,1.13,1.06,1.01,.96,.90,.85, 008370
     4.81,.77,.74,.70,.66,.63,.60,1.05,1.01,                            008380
     5                            .97,.93,.89,.85,.82,.78,.75,.72,.68,.66,.63,008390
     6.60,.58,.90,.87,.84,.81,.79,.76,.73,.71,.68,.66,.64,.62,.59,.57,  008400
     7.55,.79,.76,.74,.71,.69,.67,.65,.64,.62,.60,.59,.57,.55,.54,.52,  008410
     81.57,1.52,1.45,1.34,1.22,1.12,1.04,.97,.90,.84,.77,.74,.70,.67,   008420
     9.64,1.57,1.51,1.42,1.30,1.18,1.08,1.00,.94,.88,.82,.78,.73,.69,   008430
     1.65,.63,1.57,1.48,1.36,1.22,1.10,1.02,.95,.88,.82,.78,.73,.69,.66,008440
     2.63,.61,1.27,1.17,1.10,1.12,.96,.91,.86,.81,.77,.73,.69,.65,.63,  008450
     3.60,.58,1.06,.99,.94,.89,.84,.81,.78,.74,.71,.68,.65,.62,.60,.58, 008460
     4.56,.91,.85,.80,.77,.74,.72,.70,.68,.65,.62,.60,.58,.56,.55,.54,  008470
     5.79,.74,.70,.67,.65,.63,.62,.61,.59,.58,.56,.54,.53,.52,.50/      008480
      DATA(BAR2(I),I=1,160    )                                         008490
     A                    /.265,.270,.273,.275,.274,.273,.270,.268,.380,    008500
     1.397,.327,.314,.303,.295,.290,.285,.500,.470,.378,.352,.335,.325, 008510
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2.318,.313,.505,.445,.405,.380,.365,.353,.345,.340,.505,.460,.440,
3.410,.395,.383,.375,.370,.145,.195,.220,.240,.247,.250,.250,.250, 008520
4.262,.265,.267,.267,.267,.267,.267,.267,.380,.332,.305,.290,.283, 008530
5.282,.282,.282,.395,.355,.330,.315,.405,.298,.295,.293,.405,.385, 008540
6.365,.345,.325,.315,.307,.303,.070,.185,.225,.237,.243,.245,.247, 008550
7.248,.177,.217,.235,.243,.245,.245,.245,.244,.285,.247,.243,.247, 008560
8.250,.250,.248,.247,.305,.267,.257,.255,.255,.255,.255,.255,.317, 008570
9.287,.275,.270,.270,.270,.270,.270,0.,.175,.225,.237,.243,.245,   008580
1.245,.245,.085,.120,.165,.205,.220,.225,.227,.230,.165,.167,.170, 008590
1.192,.197,.205,.210,.213,.193,.190,.189,.190,.193,.197,           008600
2          .200,.203,.200,.197,.189,.190,.193,.195,.196,.198/      008610
 DATA(BAR2(I), I=1,210   )                                         008620
A                /1.56,1.70,1.76,1.75,1.70,1.43,1.22,1.06,.94,.85, 008630
1.77,.71,.65,.60,.56,1.56,1.735,1.76,1.62,1.48,1.35,1.24,1.09,.96, 008640
2.85,.78,.715,.66,.61,.565,1.56,1.535,1.47,1.395,1.31,1.22,1.14,   008650
31.07,1.005,.90,.805,.73,.67,.62,.58,1.26,1.30,1.275,1.233,1.17,   008660
41.11,1.05,1.00,.945,.90,.86,.775,.70,.645,.60,1.046,1.07,1.085,   008570
51.065,1.06,1.023,.986,.95,.90,.86,.822,.79,.76,.682,.635,.985,    008680
6.915,.93,.94,.94,.93,.91,.888,.855,.822,.788,.76,.73,.707,.682,   008690
7.79,.795,.80,.80,.80,.802,.805,.81,.81,.78,.755,.73,.71,.68,.661, 008700
81.57,1.56,1.85,1.82,1.64,1.41,1.21,1.06,.94,.845,.77,.71,.65,.60, 008710
9.558,1.57,1.50,1.63,1.72,1.565,1.41,1.215,1.065,.955,.86,.78,.716,008720
1.66,.61,.562,1.57,1.13,1.46,1.45,1.40,1.305,1.22,1.11,.985,.89,   008730
2.804,.73,.67,.62,.572,1.36,1.18,1.10,1.23,1.275,1.20,1.125,1.065, 008740
31.015,.94,.85,.772,.71,.65,.60,1.05,1.05,1.05,1.05,1.05,1.05,1.04,008750
41.01,.962,.92,.87,.815,.74,.68,.63,.90,.908,.915,.923,.93,.942,   008760
5.95,.935,.91,.875,.84,.815,.78,.73,.67,.79,.786,.78,.78,.779,.78, 008770
6.785,.80,.82,.83,.82,.785,.755,.73,.704/                          008780
 DATA(BAR3(I), I=211,420   )                                       008790
A                /1.50,1.88,1.92,1.80,1.59,1.36,1.17,1.03,.92,.84, 008800
1.75,.69,.635,.59,.55,1.58,1.80,1.90,1.76,1.55,1.355,1.18,1.045,   008810
2.935,.847,.77,.705,.645,.60,.56,1.58,1.46,1.35,1.445,1.43,1.32,   008820
31.20,1.08,.97,.87,.79,.72,.66,.61,.57,1.26,1.25,1.235,1.22,1.26,  008830
41.21,1.145,1.08,.995,.91,.83,.756,.693,.64,.59,1.05,1.05,1.055,   008840
51.055,1.055,1.07,1.05,1.015,.97,.925,.86,.80,.74,.68,.63,.90,.90, 008850
6.902,.903,.905,.907,.91,.91,.90,.88,.86,.83,.77,.71,.67,.79,.792, 008860
7.80,.80,.804,.81,.813,.816,.82,.822,.817,.798,.76,.74,.69,1.57,   008870
81.74,2.0,1.8,1.52,1.29,1.12,.985,.88,.795,.72,.665,.62,.575,.535, 008880
91.57,1.66,2.0,1.72,1.48,1.29,1.13,1.0,.90,.81,.74,.68,.63,.583,   008890
1.545,1.57,1.55,1.52,1.48,1.44,1.29,1.16,1.03,.93,.835,.76,.70,    008900
2.645,.60,.56,1.27,1.30,1.30,1.28,1.24,1.19,1.145,1.05,.96,.87,.80,008910
3.735,.68,.625,.58,1.06,1.055,1.05,1.04,1.02,.995,.98,.97,.97,.90, 008920
4.83,.765,.70,.655,.61,.505,.90,.885,.875,.865,.86,.858,.855,.853, 008930
5.85,.84,.785,.735,.65,.65,.795,.783,.78,.77,.762,.76,.757,.75,.75,008940
6.758,.76,.77,.74,.72,.71/                                         008950
 DATA(BAR4(I), I=1,224   )                                         008960
A                /.250,.350,.450,.465,.475,.483,.486,.490,.380,    008970
1.472,.472,.472,.480,.487,.490,.495,.5,.5,.5,.5,.5,.5,.501,.501,   008980
2.505,.54,.54,.54,.54,.54,.525,.520,.505,.542,.580,.580,.580,.580, 008990
3.580,.558,.560,.548,.585,.625,.625,.625,.625,.625,.565,.555,.595, 009000
4.633,.673,.673,.673,.673,.145,.295,.450,.475,.485,.490,.495,.495, 009010
5.267,.350,.437,.473,.483,.487,.492,.493,.380,.445,.445,.445,.488, 009020
6.502,.502,.502,.395,.440,.481,.481,.481,.532,.530,.523,.405,.433, 009030
7.470,.525,.525,.525,.570,.560,.413,.407,.503,.550,.520,.520,.520, 009040
8.615,.425,.450,.477,.510,.560,.525,.625,.625,.070,.210,.450,.477, 009050
9.485,.490,.493,.493,.177,.270,.365,.457,.475,.482,.485,.485,.285, 009060
1.360,.385,.415,.480,.485,.485,.485,.305,.355,.400,.435,.465,.511, 009070
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     2.510,.505,.317,.323,.326,.460,.487,.501,.593,.537,.330,.320,.310, 009090
     3.425,.505,.523,.550,.585,.337,.315,.300,.423,.500,.560,.580,.605, 009100
     40.00,.330,.445,.465,.475,.483,.485,.485,.085,.310,.400,.440,.455, 009110
     5.465,.470,.470,.165,.290,.380,.425,.448,.458,.467,.475,.193,.300, 009120
     6.390,.433,.457,.470,.477,.477,.200,.330,.423,.465,.485,.493,.496, 009130
     7.495,.200,.330,.423,.465,.485,.493,.496,.495,.200,.330,.423,.465, 009140
     8.485,.493,.496,.495/                                               009150
       X=AP*SQRT(ABS(1.-XM**2))                                          009160
      Y=AP*TAN(SWEEP/57.29578)                                           009170
      Z=TR                                                               009180
      IF(X.GT.7.) WRITE (6,900) X                                        009190
      IF(Z.GT.1.) WRITE (6,902) Z                                        009200
      IF(XM.GT.1.0) GO TO 1                                              009210
      CALL LOOK3(CLAR,BAR1,15,7,X,XT1,15,Y,YT1,7,Z,ZT1,4,IX,IY,IZ,1)     009220
      IF(Y.GT.4.) WRITE (6,901) Y                                        009230
      CALL LOOK3(XCPCB,BAR2,8,5,X,XT2,8,Y,YT2,5,Z,ZT2,4,IX,IY,IZ,1)      009240
      CLA=CLAR*AR                                                        009250
      RETURN                                                             009260
    1 CALL LOOK3(CLAR,BAR3,15,7,X,XT1,15,Y,YT1,7,Z,ZT1,4,IX,IY,IZ,1)     009270
      IF(Y.GT.6.) WRITE (6,901) Y                                        009280
      CALL LOOK3(XCPCB,BAR4,8,5,X,XT2,8,Y,YT2,5,Z,ZT2,4,IX,IY,IZ,1)      009290
      CLA=CLAR*AR                                                        009300
      RETURN                                                             009310
  900 FORMAT (1X,*EXTRAPOLATION REQUIRED, *10HAR*BETA = F10.4)           009320
  901 FORMAT (1X,*EXTRAPOLATION REQUIRED, *11HAR*TANSW = F10.4)          009330
  902 FORMAT (1X,*EXTRAPOLATION REQUIRED, TAPER RATIO = *F10.4)          009340
      END                                                                009350
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      SUBROUTINE CNBOD(LAD,LNC,MACH,ALPHA,D,CNB,RN)                     009360
C***********************************************************************009370
C                                                                      *009380
C     THIS SUBROUTINE CALCULATES BODY ALONE NORMAL FORCE COEFF.        *009390
C                                                                      *009400
C        LAD =    AFTER BODY LENGTH IN CAL.                            *009410
C        LNC =    NOSE LENGTH IN CAL.                                  *009420
C        MACH =   MACH NUMBER                                          *009430
C        ALPHA =  ANGLE OF ATTACH                                      *009440
C        CNB =    BODY ALONE NORMAL FORCE COEFF. ( RETURNED VALUE)     *009450
C                                                                      *009460
C***********************************************************************009470
      REAL LAD,LNC,MUD,MU,MACH,MACHT,LD,MAC                             009480
      DIMENSION CNBAT(9,4,3),CNBAM(9),CNBALA(4),CNBALN(3),              009490
     *          CNAT(13,4,4),CNAM(13),CNALA(4),CNALD(4),                009500
     *          TMUD(20),TMULD(20),                                     009510
     *          CDCT(23),CDCM(23),                                      009520
     *          CDCT2(12),CDCM2(12),TMU(14),TMUM(14)                    009530
      DATA (CNALD(I),I=1,4)/2.5,3.,3.5,4./                              009540
      DATA (CNALA(I),I=1,4)/4.,6.,8.,10./                               009550
      DATA (CNAM(I),I=1,13)/1.5,1.75,2.0,2.1,2.2,2.3,2.4,2.5,2.6,2.7,   009560
     12.8,2.9,3./                                                       009570
      DATA (CNBALN(I),I=1,3)/1.5,2.5,3.5/                               009580
      DATA (CNBALA(I),I=1,4)/5.,10.,15.,18./                            009590
      DATA (CNBAM(I),I=1,9)/.8,.85,.9,.95,1.,1.05,1.1,1.150,1.2/        009600
      DATA (TMULD(I),I=1,20)/2.,4.,6.,8.,10.,12.,14.,16.,18.,20.,22.,   009610
     124.,26.,28.,30.,32.,34.,36.,38.,40./                              009620
      DATA (TMUM(I),I=1,20)/.567,.612,.642,.662,.682,.706,.721,.736,    009630
     1.746,.756,.761,.771,.776,.786,.791,.796,.806,.811,.816,.821/      009640
      DATA(CDCM(I),I=1,23)/.0,.198,.305,.55,.6,.674,.698,.835,.875,.9,  009650
     * .94,.964,1.102,1.2,1.397,1.598,1.8,1.997,2.198,2.4,2.597,2.8,3./ 009660
      DATA(CDCT(I),I=1,23)/1.206,1.211,1.234,1.279,1.378,1.498,1.512,   009670
     * 1.418,1.433,1.6,1.874,2.07,1.796,1.692,1.557,1.478,1.428,1.393,  009680
     1 1.368,1.353,1.338,1.333,1.333/                                   009690
      DATA (((CNBAT(I,J,K),I=1,9),J=1,4),K=1,3)/4.735,4.735,4.759,      009700
     14.819,4.916,5.112,5.148,5.012,4.904,6.470,6.507,6.566,6.663,      009710
     26.759,6.843,6.928,6.952,6.892,8.807,8.855,8.976,9.096,9.215,      009720
     39.289,9.301,9.253,9.169,10.277,10.337,10.418,10.518,10.682,       009730
     410.699,10.735,10.699,10.591,4.759,4.783,4.843,4.880,4.892,4.916,  009740
     54.928,4.904,4.892,6.482,6.506,6.578,6.699,6.831,6.916,6.916,      009750
     66.819,6.735,8.735,8.783,8.880,9.,9.145,9.229,9.241,9.145,9.036,   009760
     710.133,10.181,10.277,10.398,10.518,10.651,10.831,10.94,10.94,     009770
     84.639,4.627,4.699,4.795,4.807,4.771,4.952,4.892,4.771,6.602,      009780
     96.542,6.542,6.663,6.807,6.711,6.627,6.55,6.578,8.651,8.675,8.771, 009790
     *8.928,9.048,9.120,9.096,9.036,9.036,9.988,10.,10.024,10.12,10.373,009800
     110.554,10.663,10.711,10.614/                                      009810
      DATA (((CNAT(I,J,K),I=1,13),J=1,4),K=1,4)/2.559,2.606,2.648,2.693,009820
     12.75,2.813,2.878,2.954,3.011,3.052,3.096,3.133,3.176,2.605,2.718, 009830
     22.726,2.760,2.819,2.862,2.927,3.007,3.062,3.106,3.147,3.180,3.214,009840
     32.821,2.830,2.813,2.827,2.872,2.917,2.980,3.062,3.113,3.159,3.198,009850
     43.227,3.249,2.952,2.944,2.893,2.899,2.935,2.972,3.031,3.113,3.166,009860
     53.206,3.245,3.269,3.282,2.506,2.557,2.603,2.644,2.697,2.764,2.827,009870
     62.895,2.940,2.980,3.019,3.049,3.078,2.642,2.673,2.683,2.715,2.756,009880
     72.819,2.880,2.908,2.995,3.033,3.068,3.092,3.115,2.772,2.787,2.768,009890
     82.781,2.819,2.872,2.935,3.005,3.049,3.086,3.117,3.135,3.155,2.901,009900
     92.899,2.846,2.842,2.878,2.923,2.984,3.056,3.106,3.141,3.164,3.181,009910
     *3.188,2.451,2.518,2.550,2.585,2.626,2.679,2.734,2.797,2.850,2.901,009920
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     1?.948,2.990,4.039,2.591,2.626,2.630,2.65,2.685,2.734,2.789,2.852, 009930
     22.905,2.552,2.957,3.037,3.076,2.711,2.730,2.711,2.718,2.746,2.791,009940
     32.842,2.907,2.960,3.007,3.045,3.080,3.113,2.642,2.836,2.791,2.781,009950
     42.801,2.844,2.885,2.958,3.015,3.058,3.100,3.127,3.149,2.384,2.424,009960
     52.471,2.502,2.538,2.593,2.644,2.701,2.754,2.803,2.856,2.905,2.958,009970
     62.514,2.536,2.551,2.573,2.601,2.650,2.655,2.756,2.805,2.852,2.901,009980
     72.944,2.554,2.646,2.650,2.674,2.644,2.665,2.701,2.748,2.803,2.850,009990
     82.895,2.944,2.986,3.031,2.779,2.762,2.718,2.717,2.738,2.760,2.805,010000
     92.864,2.911,2.952,2.994,3.031,3.066/                              010010
      DATA(CDCT2(I),I=1,12)/1.214,1.076,.697,.737,.270,.275,.275,.32,  010020
     1 .556,.972,1.22,1.377/                                           010030
      DATA(CDCM2(I),I=1,12)/.1,.164,.247,.254,.26,.316,.361,.395,.412, 010040
     1 .457,.486,.5/                                                   010050
      DATA(TMU(I),I=1,14)/.682,.688,.705,.73,.765,.821,.89,.965,.98,   010060
     1 .782,.8,.965,.995,1./                                           010070
      DATA(TMUM(I),I=1,14)/0.,.2,.3,.4,.5,.6,.7,.8,.9,1.,1.1,1.2,1.3,  010080
     1 1.4/                                                            010090
      RAD=.0174532925199                                               010100
      PI=3.14159265359                                                 010110
      IFLAG=0                                                          010120
      JFLAG=0                                                          010130
      KFLAG=0                                                          010140
      LD=LAD+LND                                                       010150
      RMU=.682                                                         010160
      RNC=RN*SIN(ALPHA*RAD)                                            010170
      MAC=MACH*SIN(ALPHA*RAD)                                          010180
      IF(MACH.GT.1.2) GO TO 20                                         010190
      IF(ALPHA.LT. 40.) GO TO 50                                       010200
   10 CALL LOOK3(CNRA,CNRAT,8,4,MACH,CNBAM,9,LAD,CNBALA,4,LND,CNBALN,3, 010210
     *IK,IY,IZ,1)                                                      010220
      CNA=CNRA-.4*LAD                                                  010230
  100 IF(IFLAG.EQ.1)GO TO 30                                           010240
      IF(JFLAG.EQ.1) GO TO 40                                          010250
      GO TO 55                                                         010260
   50 KFLAG=1                                                          010270
   55 RD=((LND )**2+.25)                                               010280
      SAP = D**2*(-2.*LND*(RD-.5)+LND*SQRT(RD**2-LND**2)+RD**2*ASIN(LND 010290
     */RD))                                                            010300
      SP = D**2*LAD + SAP                                              010310
      SREF=PI*(D/2.)**2                                                010320
      IF(RNC.GT.200000..AND.RNC.LT.5000000..AND.MAC.GT..1.AND.MAC.LT..5)010330
     1 GO TO 200                                                       010340
      CALL LOOK1(CDC,CDCT,MAC ,CDCM,20,IX,1)                           010350
  105 CALL LOOK1(MUD,TMUD,LD,TMULD,20,IX,1)                            010360
      IF(MAC.GE.1.4) GO TO 70                                          010370
      CALL LOOK1(MU,TMU,MAC ,TMUM,14,IX,1)                             010380
      IF(MAC .GE..6) GO TO 80                                          010390
      MU=((MUD-RMU)/RMU)*((.6-MAC)/.6)+MU                              010400
      GO TO 80                                                         010410
  200 CALL LOOK1(CDC,CDCT2,MAC ,CDCM2,12,IX,1)                         010420
      GO TO 105                                                        010430
   70 MU=1.0                                                           010440
   80 IF(KFLAG.EQ.1)GO TO 75                                           010450
      CNPI2=CDC*MU*SP/SREF                                             010460
      A=ALPHA*RAD                                                      010470
      CNB=(A-(6.*A**2)/PI + (12.*A**3)/PI**2 - (12.*A**4)/PI**3        010480
     * +(4.*A**5)/PI**4)*CNA+ ((16.*A**2)/PI**2-(32.*A**3)/PI**3       010490
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     * + (16.*A**4)/PI**4)*CNPI2
      RETURN
   20 IF(MACH.LT.1.5) GO TO 90
  110 CALL LOOK3(CNA,CNAT,13,4,MACH,CNAM,13,LAD,CNALA,4,LND,CNALD,4,
     *IX,IY,IZ,1)
      GO TO 100
   30 CNA1=CNA
      IFLAG=0
      MACH=1.5
      JFLAG=1
      GO TO 110
   40 CNA2=CNA
      MACH = MACHT
      JFLAG=0
      CNA=CNA2-(CNA2-CNA1)*(1.5-MACH)/.3
      GO TO 50
   90 IFLAG = 1
      MACHT=MACH
      MACH = 1.2
      GO TO 10
   75 A=ALPHA*RAD
      CNB=SIN(2.*A)*COS(A/2.)+CDC*MU*(SP/SREF)*(SIN(A))**2
      RETURN
      END
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SUBROUTINE XCPBOD     74/74    OPT=1                    FTN 4.2+74355      04/27/78  09.25.22.      PAGE    1

      SUBROUTINE XCPBOD(LAD,LND,D,MACH,ALPHA,XCPB)
C*******************************************************************       010740
C                                                                   *******010750
C     THIS SUBROUTINE CALCULATES BODY ALONE CENTER OF PRESSURE             010760
C       LAD =     AFTER BODY LENGTH IN CAL.                               *010770
C       LND =     NOSE LENGTH IN CAL.                                     *010780
C       D =       BODY DIAMETER IN INCHES                                 *010790
C       MACH =    FREE STREAM MACH NUMBER                                 *010800
C       ALPHA =   ANGLE OF ATTACH IN DEGREES                              *010810
C       XCPB =    BODY CENTER OF PRESSURE FROM NOSE IN CAL.               *010820
C                                                                         *010830
C*************************************************************************010840
      REAL MACH,LAD,LND,LN,LD,MACHT,LA                           *********010850
      DIMENSION XOT1(9,4,3),XOT1M(9),XOT1LA(4),XOT1LN(3),                  010860
     *          XOT2(7,4,3),XOT2M(7),XOT2LA(4),XOT2LN(3),                  010870
     *          DELXT(23),DELXM(23)                                        010880
      DATA (((XOT1(I,J,K),I=1,9),J=1,4),K=1,3)/4.012,4.012,4.012,4.036,    010890
     13.988,3.868,3.916,3.820,3.604,6.246,6.294,6.462,6.655,6.799,6.631,   010900
     26.679,6.703,6.511,10.066,10.162,10.330,10.715,10.979,10.955,         010910
     310.787,10.330,9.730,12.228,12.276,12.492,12.853,13.237,13.381,       010920
     413.045,12.565,12.180,4.492,4.589,4.733,4.805,4.709,4.348,4.372,      010930
     54.420,4.324,7.063,7.135,7.231,7.423,7.568,7.544,7.303,6.967,6.607,   010940
     610.282,10.426,10.787,11.171,11.459,11.387,10.955,10.354,9.994,       010950
     712.517,12.781,13.189,13.550,13.862,13.838,13.862,14.126,13.982,      010960
     84.877,4.887,5.021,5.333,5.405,5.141,4.997,4.877,4.805,7.592,7.592,   010970
     97.736,7.976,8.240,8.024,8.,7.976,7.856,11.147,11.267,11.532,         010980
     *12.084,12.517,12.348,12.252,12.132,12.060,13.285,13.309,13.429,      010990
     113.814,14.799,15.375,15.568,15.736,15.351/                           011000
      DATA (XOT1M(I),I=1,9)/.8,.85,.9,.95,1.,1.05,1.1,1.15,1.2/            011010
      DATA (XOT1LA(I),I=1,4)/6.,10.,15.,18./                               011020
      DATA (XOT1LN(I),I=1,3)/1.5,2.5,3.5/                                  011030
      DATA (((XOT2(I,J,K),I=1,7),J=1,4),K=1,3)/2.852,2.802,2.815,2.877,    011040
     12.975,3.42,3.852,3.914,3.815,3.815,3.877,3.988,4.432,4.864,4.951,    011050
     24.79,4.753,4.79,4.901,5.37,5.827,5.988,5.802,5.753,5.790,5.914,      011060
     36.346,6.765,3.296,3.21,3.21,3.272,3.383,3.79,4.198,4.37,4.235,       011070
     44.21,4.259,4.37,4.802,5.198,5.42,5.247,5.198,5.235,5.321,5.741,      011080
     56.16,6.432,6.198,6.136,6.16,6.259,6.679,7.074,3.556,3.444,3.432,     011090
     63.494,3.605,4.025,4.457,4.605,4.457,4.420,4.481,4.580,5.025,5.444,   011100
     75.691,5.481,5.407,5.444,5.556,6.,6.420,6.716,6.469,6.383,6.407,      011110
     85.494,6.938,7.370/                                                   011120
      DATA (XOT2M(I),I=1,7)/1.5,1.75,2.,2.25,2.5,3.5,4.5/                  011130
      DATA (XOT2LA(I),I=1,4)/4.,6.,8.,10./                                 011140
      DATA (XOT2LN(I),I=1,3)/2.5,3.5,4./                                   011150
      DATA (DELXT(I),I=1,23)/.169,.157,.138,.124,.11,.091,.071,.118,       011160
     1.162,.201,.236,.254,.261,.269,.274,.278,.283,.287,.288,.289,.288,    011170
     2.287,.285/                                                           011180
      DATA (DELXM(I),I=1,23)/.6,.699,.801,.855,.902,.952,1.,1.1,1.2,1.3,   011190
     11.4,1.465,1.5,1.6,1.7,1.8,2.,2.2,2.4,2.596,2.798,2.9,3./             011200
      JFLAG = 0                                                            011210
      IFLAG = 0                                                            011220
      LD = LND+LAD                                                         011230
      IF(MACH.GT. 1.2) GO TO 10                                            011240
  120 CALL LOOK3(XO,XOT1,9,4,MACH,XOT1M,5,LAD,XOT1LA,4,LND,XOT1LN,3,       011250
     *IX,IY,IZ,1)                                                          011260
   30 XO = XO-.4*LAD                                                       011270
      IF(IFLAG.EQ.1) GO TO 100                                             011280
      IF(JFLAG.EQ.1) GO TO 110                                             011290
                                                                           011300
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  140 CALL LOOK1(DELX,DELXT,MACH,DELXM,23,IX,1)
      DELX = DELX*LD
      X20 = X0+DELX
      A = ALPHA
      A0 = 1.+(7.*A**3/28000.-21.*A**2/2800.)
      A1 = 23.*A**2/2800.-8.*A**3/28000.
      A2 = A**3/28000. - 2.*A**2/2800.
      LN = LND*D
      LA = LAD*D
      R = D/4.*LND**2*D
      SPN = LN*SQRT(-LN**2+R**2)+R**2*ASIN(LN/R)-2.*(R-D/2.)*LN
      XBARN = 2.*(-R**3/3.+ (R**2-LN**2)/3.*SQRT(R**2-LN**2)+(LN**2/2.)
     **SQRT(R**2-LN**2)+(LN*R**2/2.)*ASIN(LN/R))-(R-D/2.)*LN**2
      SPA = LA*D
      XBARA = (LN+LA/2.)*LA*D
      XBAR = (XBARN+XBARA)/(SPN+SPA)
      XPI2 = XBAR/D
      IF(ALPHA .GT. 20.) GO TO 20
      XCPB = A0*X0 + A1*X20+A2*XPI2
   70 CONTINUE
      RETURN
   10 IF(MACH.LT. 1.5) GO TO 90
  130 CALL LOOK3(X0,XOT2,7,4,MACH,XOT2M,7,LAD,XOT2LA,4,LND,XOT2LN,3,
     *IX,IY,IZ,1)
      GO TO 30
   20 IF(MACH.GE. 1.) GO TO 40
      APRIM = 50.
      GO TO 50
   40 APRIM = 20.
   50 AM = (X20-XPI2)/(APRIM-90.)
      IF(ALPHA.LT. APRIM) GO TO 60
      IF(ALPHA.LE. 160.) GO TO 80
      X160 = 70.*AM + XPI2
      B0 = (-51840000. + 900000.*ALPHA-5200.*ALPHA**2+10.*ALPHA**3)/
     *4000.
      B1 =(4864000.-86400.*ALPHA+510.*ALPHA**2-ALPHA**3)/4000.
      B2 = (-4860000.+86400.*ALPHA-510.*ALPHA**2+ALPHA**3)/4000.
      XCPB = B0*AM + B1*(LAD+LND) + B2*X160
      GO TO 70
   60 XCPB = X20
      GO TO 70
   80 XCPB = AM*(ALPHA-APRIM)+X20
      GO TO 70
   90 IFLAG = 1
      MACHT = MACH
      MACH = 1.2
      GO TO 120
  100 X01 = X0
      IFLAG = 0
      JFLAG = 1
      MACH = 1.5
      GO TO 130
  110 X02 = X0
      JFLAG = 0
      MACH = MACHT
      X0 = X02-(X02-X01)*(1.5-MACH)/.3
      GO TO 140
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115       END                                                         011880
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      SUBROUTINE IBTT(LAMDA,MACH,AR,ALPHA,PHI,S,D,IBT)                  011890
C*********************************************************************011900
C                                                                      *011910
C     THIS SUBROUTINE CALCULATES BODY NORMAL CARRYOVER FORCE COEFF.    *011920
C                                                                      *011930
C        LAMDA     = TAIL TAPER RATIO                                  *011940
C        MACH      = MACH NUMBER                                       *011950
C        AR        = TAIL ASPECT RATIO                                 *011960
C        ALPHA     = ANGLE OF ATTACK                                   *011970
C        PHI       = BODY ROLL ANGLE                                   *011980
C        S         = TAIL SEMI SPAN(INCLUDING BODY                     *011990
C        D         = BODY DIAMETER                                     *012000
C        IBT       = BODY CARRY OVER FORCE COEFF.  (RETURNED VALUE)    *012010
C                                                                      *012020
C*********************************************************************012030
      REAL LAMDA,MACH,IABAS,IABAST,IB,IBT,ICBAS,ICBAST,I1BAS,I2BAS,     012040
     *I3BAS,MACHT,I1,I2,I3,IBT1,IBT2,IABDB,IBTAR,ICBADB,IBTO,IBBT,IA,IC 012050
     *,IBTM                                                             012060
      DIMENSION TDIBT(6,3,3),DIBTAF(6),DIBTLM(3),DIBTAR(3),             012070
     *          IBBT(5,3),IBTM(5),IBTAR(3),                             012080
     *          FCART(6),FCATT(6),                                      012090
     *          ICBAST(2),ICBADB(2),                                    012100
     *          FAMMT(5,3),FAMAC(5),FAMAR(3),                           012110
     *          FAART(11),FFAR(11),                                     012120
     *          IABAST(2),IABDB(2),                                     012130
     *          TF3AR(10),TFAR(10),                                     012140
     *          TF2DB(13),TFDB2(13),                                    012150
     *          TF2M(2),TF2MACH(2),                                     012160
     *          TI2BAS(11),TI2BLM(11),                                  012170
     *          TF1DB(13),TFDB1(13),                                    012180
     *          TI1BAS(2),TI1BLM(2)                                     012190
      DATA (((TDIBT(I,J,K),I=1,6),J=1,3),K=1,3)/0.,0.018,.106,.405,.884,012200
     11.639,0.,.02,.119,.332,.649,1.117,.0,.023,.109,.299,.557,.768,.0, 012210
     2.015,.068,.21,.408,.646,.0,.018,.081,.167,.296,.446,.0,.02,.071,  012220
     3.149,.256,.304,.0,.013,.043,.139,.218,.271,0.,.013,.051,.109,.155,012230
     4.205,.0,.015,.043,.099,.137,.122/                                 012240
      DATA (DIBTAF(I),I=1,6)/0.,5.,10.,15.,20.,25./                     012250
      DATA (DIBTLM(I),I=1,3)/0.,.5,1./                                  012260
      DATA (DIBTAR(I),I=1,3)/.5,1.,2./                                  012270
      DATA ((IBBT(I,J),I=1,5),J=1,3)/1.484,-.113,-.239,.73,1.006,.252,  012280
     1-.491,-.805,-.252,.403,.491,-.226,-.491,-.39,.415/                012290
      DATA (IBTM(I),I=1,5)/.6,.8,.9,1.,1.3/                             012300
      DATA (IBTAR(I),I=1,3)/.5,1.,2./                                   012310
      DATA (FCART(I),I=1,6)/2.496,1.941,1.462,1.109,1.,1./              012320
      DATA (FCATT(I),I=1,6)/.5,.599,.688,.803,.93,2./                   012330
      DATA (ICBAST(I),I=1,2)/.5,.3/                                     012340
      DATA (ICBADB(I),I=1,2)/.3,.5/                                     012350
      DATA ((FAMMT(I,J),I=1,5),J=1,3)/1.78,1.668,1.494,1.332,1.,2.,2.,  012360
     12.,2.,2.,3.,3.,3.,3.,3./                                          012370
      DATA (FAMAC(I),I=1,5)/.6,.8,.9,1.,1.3/                            012380
      DATA (FAMAR(I),I=1,3)/.5,1.,2./                                   012390
      DATA (FAART(I),I=1,11)/2.597,2.118,1.714,1.311,1.134,1.,1.,1.,1., 012400
     11.,1./                                                            012410
      DATA (FFAR(I),I=1,11)/.487,.564,.628,.731,.808,.91,1.,1.103,1.295,012420
     11.5,2./                                                           012430
      DATA (IABAST(I),I=1,2)/1.5,1./                                    012440
      DATA (IABDB(I),I=1,2)/.3,.5/                                      012450
```

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      DATA (TF3AR(I),I=1,10)/.013,.176,.366,.504,.643,.756,.832,.908,
     1.971,1./                                                          012460
      DATA (TFAR(I),I=1,10)/.5,.655,.856,1.,1.186,1.364,1.5,1.669,1.835,012470
     12./                                                               012480
      DATA (TF2DP(I),I=1,13)/1.,.823,.656,.544,.43,.342,.278,.19,.139,  012490
     1.114,.076,.076,.0/                                                012500
      DATA (TFDP2(I),I=1,13)/.3,.317,.333,.35,.368,.385,.4,.424,.439,.45012510
     1,.468,.485,.5/                                                    012520
      DATA (TF2M(I),I=1,2)/.6,1.375/                                    012530
      DATA (TF2MACH(I),I=1,2)/2.,3./                                    012540
      DATA (TI2BAS(I),I=1,11)/-.715,-.992,-1.28,-1.494,-1.644,-1.757,   012550
     1-1.845,-1.913,-1.996,-2.,-2./                                     012560
      DATA (TI2BLM(I),I=1,11)/0.,.025,.082,.139,.196,.247,.31,.386,.475,012570
     1.5,1./                                                            012580
      DATA (TF1DP(I),I=1,13)/1.,.89,.788,.699,.636,.585,.508,.458,.419, 012590
     1.394,.369,.356,.343/                                              012600
      DATA (TFDB1(I),I=1,13)/.3,.316,.333,.349,.367,.38,.4,.418,.435,   012610
     1.449,.466,.486,.5/                                                012620
      DATA (TI1BAS(I),I=1,2)/1.,.5/                                     012630
      DATA (TI1BLM(I),I=1,2)/0.,1./                                     012640
      IFLAG = 0                                                         012650
      JFLAG = 0                                                         012660
      PI = 3.141592653                                                  012670
      RAD = PI/180.                                                     012680
      B = 2.*S                                                          012690
      DB = D/B                                                          012700
      IF(MACH.GT. 1.3) GO TO 10                                         012710
      IF(MACH .LT. .6) GO TO 20                                         012720
   30 CALL LOOK1(IABAS,IABAST,DB,IABDB,2,IX,1)                          012730
      CALL LOOK1(FAAR,FAART,AR,FFAR,11,IX,1)                            012740
      CALL LOOK2(FAMM,FAMMT,5,MACH,FAMAC,5,AR,FAMAR,3,IX,IY,1)          012750
      FAM = FAMM - AR                                                   012760
      IA = IABAS*FAAR*FAM                                               012770
      CALL LOOK2(IB,IBBT,5,MACH,IBTM,5,AR,IBTAR,3,IX,IY,1)              012780
      CALL LOOK1(ICBAS,ICBAST,DB,ICBADB,2,IX,1)                         012790
      CALL LOOK1(FCAR,FCART,AR,FCATT,6,IX,1)                            012800
      IC = ICBAS*FCAR                                                   012810
      A = ALPHA*RAD                                                     012820
      IF(ALPHA .GT. 130.) GO TO 40                                      012830
      IBTO=(.172*IB+2.562*IA)*A-(.394*IB+1.93*IA)*A**2+(.353*IA+.226*IB)012840
     **A**3                                                             012850
      GO TO 50                                                          012860
   40 IBTO = 19.592*IB-39.869*IC+(30.271*IC-13.286*IB)*A+(2.244*IB-5.596012870
     **IC)*A**2                                                         012880
   50 IF(PHI .GT. 90.) GO TO 55                                         012890
      P = PHI*RAD                                                       012900
      GO TO 56                                                          012910
   55 P = (PHI-90.)*RAD                                                 012920
   56 IF(ALPHA .GT. 25.) GO TO 60                                       012930
      CALL LOOK3(DIBT,TDIBT,6,3,ALPHA,DIBTAF,6,LAMDA,DIBTLM,3,AR,DIBTAR,012940
     *3,IX,IY,IZ,1)                                                     012950
      GO TO 70                                                          012960
   60 CALL LOOK3(DIBT,TDIBT,6,3,25.,DIBTAF,6,LAMDA,DIBTLM,3,AR,DIBTAR,  012970
     *3,IX,IY,IZ,1)                                                     012980
   70 IBT = IBTO+DIBT*(-16.*P**2/(PI/2.)**2+32.*P**3/(PI/2.)**3-16.*P**4012990
     */(PI/2.)**4)                                                      013000
      IF(IFLAG .EQ. 1) GO TO 80                                         013010
                                                                        013020
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          RETURN                                                        013030
       80 IFLAG = 0                                                     013040
        . JFLAG = 1                                                     013050
          IBT1=IBT                                                      013060
          MACH = 2.0                                                    013070
          GO TO 90                                                      013080
      100 JFLAG = 0                                                     013090
          IBT2 = IBT                                                    013100
          MACH = MACHT                                                  013110
          IBT = IBT2-(2.0-MACH)*(IBT2-IBT1)/.7                          013120
          RETURN                                                        013130
       10 IF(MACH .GE. 2.) GO TO 90                                     013140
          IFLAG = 1                                                     013150
          MACHT = MACH                                                  013160
          MACH = 1.3                                                    013170
          GO TO 30                                                      013180
       90 CALL LOOK1(I1BAS,TI1BAS,LAMDA,TI1BLM,2,IX,1)                  013190
          CALL LOOK1(F1DB,TF1DB,DB,TFDB1,13,IX,1)                       013200
          I1 = I1BAS*F1DB                                               013210
          CALL LOOK1(I2BAS,TI2BAS,LAMDA,TI2BLM,11,IX,1)                 013220
          CALL LOOK1(F2M,TF2M,MACH,TF2MACH,2,IX,1)                      013230
          CALL LOOK1(F2DB,TF2DB,DB,TFDB2,13,IX,1)                       013240
          I2 = I2BAS*F2M*F2DB                                           013250
          CALL LOOK1(F3AR,TF3AR,AR,TFAR,10,IX,1)                        013260
          I3 = .5*F3AR                                                  013270
          IF (ALPHA .GT. 90.) GO TO 105                                 013280
          IBTO = I1*SIN(ALPHA*RAD)                                      013290
          GO TO 110                                                     013300
      105 IF ( ALPHA .GT. 115.) GO TO 120                               013310
          IBTO = I1-(I1-I2)*SQRT((ALPHA-90.)/25.)                       013320
          GO TO 110                                                     013330
      120 IBTO = -19.325*I3+11.926*I2+(15.816*I3-8.382*I2)*(ALPHA*RAD)  013340
         *+(1.46*I2-3.076*I3)*(ALPHA*RAD)**2                            013350
      110 IBT = IBTO                                                    013360
          IF (JFLAG .EQ. 1) GO TO 100                                   013370
          RETURN                                                        013380
       20 WRITE(6,500)                                                  013390
      500 FORMAT(1H ,*MACH NUMBER OUTSIDE ALLOWABLE LIMITS*)            013400
          RETURN                                                        013410
          END                                                           013420
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SUBROUTINE XCPBTT   74/74   OPT=1   FTN 4.2+74355   04/27/78 09.26.45.   PAGE   1

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      SUBROUTINE XCPBTT(ALPHA,LAMDA,MACH,AR,D,S,XCPBT)                    013430
C*********************************************************************013440
C                                                                     *013450
C     THIS SUBROUTINE CALCULATES TAIL-TO-BODY CARRY OVER NORMAL FORCE *013460
C     CENTER OF PRESSURE.                                             *013470
C                                                                     *013480
C        ALPHA      = ANGLE OF ATTACH (DEGS.)                         *013490
C        LAMDA      = TAIL TAPER RATIO                                *013500
C        MACH.      = MACH NUMBER                                     *013510
C        AR         = ASPECT RATIO                                    *013520
C        D          = BODY DIAMETER                                   *013530
C        S          = TAIL SEMI-SPAN(INCLUDING BODY)                  *013540
C        XCPT       = TAIL TO BODY CARRY-OVER NORMAL FORCE CENTER OF   013550
C                     PRESSURE/TAIL ROOT CHORD, MEASURED FROM,        *013560
C                      ROOT CHORD LEADING EDGE - AFT (ALPHA 0 TO 90 DEG) *013570
C                      ROOT CHORD TRAILING EDGE - FWD (ALPHA 90 TO 180 DEG)013580
C                                                                     *013590
C*********************************************************************013600
      REAL LAMDA,MACH                                                      013610
      DIMENSION TCP4(8,4,3),TBAR(8),TDB(4),TLAM(3),                        013620
     *          TCP3(8,4,3),TCP2(8,4,3),TCP1(8,4,3)                        013630
      DATA (((TCP4(I,J,K),I=1,8),J=1,4),K=1,3)/0.,.184,.369,.426,.5,.5, 013640
     1.5,.5,0.,.241,.44,.582,.723,.78,.851,.879,0.,.369,.681,.95,1.135, 013650
     21.291,1.433,1.546,0.,.638,1.106,1.475,1.801,2.113,2.355,2.582,0., 013660
     3.261,.456,.489,.5,.5,.5,.5,0.,.394,.672,.806,.894,.978,1.056,      013670
     41.128,0.,.572,.95,1.2,1.4,1.6,1.79,1.97,0.,.956,1.478,1.883,2.256,013680
     52.578,2.867,3.106,0.,.333,.494,.5,.5,.5,.5,.5,0.,.539,.772,.883,  013690
     6.994,1.089,1.189,1.278,0.,.789,1.122,1.4,1.661,1.911,2.144,2.361, 013700
     70.,1.161,1.783,2.322,2.78,3.26,3.65,4.03/                          013710
      DATA (TBAR(I),I=1,8)/0.,1.,2.,3.,4.,5.,6.,7./                        013720
      DATA (TDB(I),I=1,4)/0.,.2,.4,.6/                                     013730
      DATA (TLAM(I),I=1,3)/0.,.5,1./                                       013740
      DATA (((TCP3(I,J,K),I=1,8),J=1,4),K=1,3)/.5,.5,.5,.5,.5,.5,.5,.5, 013750
     1.5,.561,.597,.63,.646,.659,.656,.666,.5,.616,.659,.666,.666,.666, 013760
     2.666,.666,.5,.666,.666,.666,.666,.666,.666,.666,.3,.426,.482,.498,013770
     3.5,.5,.5,.5,.298,.577,.63,.649,.666,.666,.666,.666,.3,.643,.662,  013780
     4.666,.666,.666,.666,.666,.3,.666,.666,.666,.666,.666,.666,.666,   013790
     50.,.354,.449,.492,.5,.5,.5,.5,0.,.6,.639,.666,.666,.666,.666,     013800
     6.666,0.,.656,.666,.666,.666,.665,.666,.666,0.,.666,.666,.666,.666,013810
     7.666,.666,.666/                                                      013820
      DATA (((TCP2(I,J,K),I=1,8),J=1,4),K=1,3)/0.,.164,.218,.24,.25,.25,013830
     1.25,.25,0.,.129,.17,.189,.195,.195,.195,.195,0.,.11,.15,.168,.174,013840
     2.174,.174,.174,0.,.1,.136,.156,.163,.163,.163,.163,0.,.16,.223,   013850
     3.244,.25,.25,.25,.25,.0,.14,.194,.215,.221,.221,.221,.221,0.,.128,013860
     4.183,.204,.21,.21,.21,.21,0.,.118,.175,.196,.203,.203,.203,.203,  013870
     50.,.159,.213,.233,.244,.25,.25,.25,0.,.159,.213,.233,.244,.25,.25,013880
     6.25,0.,.159,.213,.233,.244,.25,.25,.25,0.,.159,.213,.233,.244,    013890
     7.25,.25,.25/                                                         013900
      DATA (((TCP1(I,J,K),I=1,8),J=1,4),K=1,3)/.5,.436,.367,.316,.284,  013910
     1.265,.253,.249,.5,.469,.436,.412,.402,.402,.402,.402,.5,.492,.48, 013920
     2.473,.469,.469,.469,.469,.5,.509,.511,.511,.511,.511,.511,.511,   013930
     3.25,.25,.25,.25,.25,.25,.25,.25,.25,.294,.316,.327,.327,.327,.327,013940
     4.327,.25,.305,.335,.353,.358,.361,.361,.361,.25,.316,.353,.371,   013950
     5.378,.378,.378,.378,0.,.162,.219,.233,.246,.251,.251,.251,0.,.162,013960
     6.219,.233,.246,.251,.251,.251,0.,.162,.219,.233,.246,.251,.251,   013970
     7.251,0.,.162,.219,.233,.246,.251,.251,.251/                          013980
      PI = 3.141592653                                                     013990
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      RAD = PI/180.                                                      014000
      DP = D/(2.*S)                                                      014010
      IF(ALPHA.GT.90.) GO TO 10                                          014020
      IF(MACH.GT. 1.) GO TO 20                                           014030
      BETA = SQRT(1.-MACH**2)                                            014040
      BAR = BETA*AR                                                      014050
      CALL LOOK3(XCPBO,TCP1,B,4,BAR,TBAR,8,DB,TDB,4,LAMDA,TLAM,3,IX,IY,  014060
     *IZ,1)                                                              014070
   40 A = ALPHA*RAD                                                      014080
      DIF = (2.*A**3)/(PI/2.)**3-(3.*A**2)/(PI/2.)**2                    014090
      XCPBT = XCPBO+DIF*(XCPBO-.5)                                       014100
      RETURN                                                             014110
   10 IF(MACH.GT. 1.) GO TO 30                                           014120
      BETA = SQRT(1.-MACH**2)                                            014130
      BAR = BETA*AR                                                      014140
      CALL LOOK3(XCPBO,TCP2,B,4,BAR,TBAR,8,DB,TDB,4,LAMDA,TLAM,3,IX,IY,  014150
     *IZ,1)                                                              014160
   50 A = (180.-ALPHA)*RAD                                               014170
      DIF = (2.*A**3)/(PI/2.)**3-(3.*A**2)/(PI/2.)**2                    014180
      XCPBT = XCPBO + DIF*(XCPBO-.5)                                     014190
      RETURN                                                             014200
   20 BETA = SQRT(MACH**2-1.)                                            014210
      BAR = BETA*AR                                                      014220
      CALL LOOK3(XCPBO,TCP3,B,4,BAR,TBAR,8,DB,TDB,4,LAMDA,TLAM,3,IX,IY,  014230
     *IZ,1)                                                              014240
      GO TO 40                                                           014250
   30 BETA = SQRT(MACH**2-1.)                                            014260
      BAR = BETA*AR                                                      014270
      CALL LOOK3(XCPBO,TCP4,B,4,BAR,TBAR,8,DB,TDB,4,LAMDA,TLAM,3,IX,IY,  014280
     *IZ,1)                                                              014290
      GO TO 50                                                           014300
      END                                                                014310
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      SUBROUTINE XCPTBR(MACH,AR,LAMDA,D,S,CR,ALPHA,PHI,XCPTBU,XCPTBL)   014320
C*****************************************************************************014330
C     THIS SUBROUTINE CALCULATES THE TAIL CHORDWISE CENTER OF PRESSURE/*014340
C     TAIL ROOT CHORD MEASURED AFT FROM ROOT CHORD LEADING EDGE        *014350
C                                                                       *014360
C        ALPHA    =      ANGLE OF ATTACK  (DEG)                         *014370
C        AR       =      ASPECT RATIO                                   *014380
C        CR       =      ROOT CHORD ( TAIL ) .                          *014390
C        D        =      BODY DIAMETER                                  *014400
C        LAMDA    =      TAPER RATIO                                    *014410
C        MACH     =      MACH NUMBER                                    *014420
C        PHI      =      ROLL ANGLE (DEGREES)                           *014430
C        S        =      SEMI-SPAN (TAIL PLUS BODY RADIUS)              *014440
C        XCPTBU   =      CHORDWISE CENTER OF PRESSURE  (UPPER BOUND)    *014450
C        XCPTBL   =      CHORDWISE CENTER OF PRESSURE  (LOWER BOUND)    *014460
C                                                                       *014470
C*****************************************************************************014480
      DIMENSION TOPHI1(10),DPLMT(10)                                      014490
      REAL LAMDA,MACH                                                     014500
      DATA(TOPHI1(I),I=1,10)/40.,35.842,32.475,29.703,27.327,24.356,21.9014510
     $8,20.198,20.,20./                                                   014520
      DATA(DPLMT(I),I=1,10)/0.0,0.027,0.067,0.104,0.144,0.211,0.302,0.4014530
     $6,0.50,1.0/                                                         014540
      DCR = D/CR                                                          014550
      ALP = ALPHA                                                         014560
      B=2.*S                                                              014570
      IF (PHI.LE.90.) GO TO 10                                            014580
      IF (PHI.GT.90.) GO TO 20                                            014590
   10 CONTINUE                                                            014600
      ALR = (1.0 + D/B)*(TAN(ALP/57.29578)*SIN(PHI/57.29578))             014610
      ALPRES = ATAN(ALR)*57.29578                                         014620
      CALL  XCPTT(ALPRES,LAMDA,MACH,AR,XCPTB)                             014630
      XCPTBU = XCPTB                                                      014640
      XCPTBL = XCPTBU                                                     014650
      GO TO 30                                                            014660
   20 CONTINUE                                                            014670
      CALL PHCC(ALPHA,MACH,DCR,PHC1)                                      014680
      PHIC = PHC1 + 90.0                                                  014690
      CALL LOOK1(DPHI1,TOPHI1,LAMDA,DPLMT,10,IX,1)                        014700
      PHI1 = PHIC-DPHI1                                                   014710
      PHI2 = PHIC+DPHI1                                                   014720
      CALL XCPTT(ALPHA,LAMDA,MACH,AR,XCPTB)                               014730
      XCPTBU = XCPTB                                                      014740
      XCPTBL = XCPTBU                                                     014750
      IF(PHI.LT.PHI1) GO TO 30                                            014760
      ALE = (1.0 + D/S)*TAN(ALP/57.29578)                                 014770
      ALPEFF = ATAN(ALE)*57.29578                                         014780
      CALL XCPTT(ALPEFF,LAMDA,MACH,AR,XCPTB1)                             014790
      IF(PHI.GT.PHIC) GO TO 25                                            014800
      XCPTBU = XCPTB1 + ((PHI-PHI1)/(PHIC-PHI1))**2*(1.0-XCPTB1)          014810
      XCPTBL = XCPTB1 * (1.0-((PHI-PHI1)/(PHIC-PHI1))**2)                 014820
      GO TO 30                                                            014830
   25 CONTINUE                                                            014840
      CALL XCPTT(0.,LAMDA,MACH,AR,XCPTBA)                                 014850
      IF(PHI.GT.PHI2) GO TO 40                                            014860
      XCPTBU = XCPTBA+(((PHI2-PHI)/(PHI2-PHIC))**2)*(1.0-XCPTBA)          014870
      XCPTBL = XCPTBA*(1.0-((PHI2-PHI)/(PHI2-PHIC))**2)                   014880
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      GO TO 30                                                   014890
   40 CONTINUE                                                   014900
      XCPTHU = XCPTEA                                            014910
      XCPTBL = XCPTBU                                            014920
   30 CONTINUE                                                   014930
      RETURN                                                     014940
      END                                                        014950
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      SUBROUTINE YCPTS (LAMDA,PHI,ALPHA,MACH,S,D,CR,YCPT)                014960
C*********************************************************************014970
C     THIS SUBROUTINE CALCULATES THE TAIL SPANWISE CENTER OF PRESSURE  *014980
C                                                                     *014990
C          ALPHA   =    ANGLE OF ATTACK  (DEG)                        *015000
C          AR      =    ASPECT RATIO                                  *015010
C          CR      =    ROOT CHORD ( TAIL )                           *015020
C          D       =    BODY DIAMETER                                 *015030
C          LAMDA   =    TAPER RATIO                                   *015040
C          MACH    =    MACH NUMBER                                   *015050
C          PHI     =    ROLL ANGLE (DEGREES)                          *015060
C          S       =    SEMI-SPAN (TAIL PLUS BODY RADIUS)             *015070
C          YCPT    =    SPANWISE CENTER OF PRESSURE                   *015080
C                                                                     *015090
C*********************************************************************015100
      REAL LAMDA,MACH,KY                                                015110
      DIMENSION TLAMDA(3),TRADB(11),  TYCPT(11,3),TMACH(6),TALPHA(10)   015120
      DIMENSION TKY(10,6)                                               015130
      DATA (TLAMDA(I),I=1,3)/0.,.5,1./                                  015140
      DATA (TRADB(I),I=1,11)/0.05,0.1,0.2,0.3,0.4,0.5,0.6,0.7,0.8,0.9,0.015150
     *55/                                                               015160
      DATA((TYCPT(I,J),I=1,11),J=1,3)/0.311,0.303,0.296,0.298,.302,.307,015170
     1.31,.318,.325,.330,.331,.425,.414,.402,.401,.402,.407,.416,.424,  015180
     2.430,.436,.441,.485,.471,.459,.455,.459,.463,.469,.477,.487,.493, 015190
     3.499/                                                             015200
      DATA(TMACH(I),I=1,6)/0.8,1.2,1.4,1.6,1.75,3.0/                    015210
      DATA(TALPHA(I),I=1,10)/0.0,5.0,10.0,15.0,20.0,25.0,30.0,35.0,40.0,015220
     $45.0/                                                             015230
      DATA((TKY(I,J),I=1,10),J=1,6)/1.09,1.09,1.09,1.09,1.03,0.98,0.92,0015240
     1.92,0.92,0.92,1.09,1.09,1.09,1.09,1.03,0.98,0.92,0.92,0.92,0.92,1 015250
     1.05,1.05,1.05,1.05,1.021,0.99,0.95,0.95,0.95,0.95,1.025,1.025,1.02015260
     $5,1.025,1.01,0.99,0.978,0.978,0.978,0.976,1.0,1.0,1.0,1.0,1.0,1.0,015270
     11.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0/          015280
      DCR = D/CR                                                        015290
      CALL PHCC(ALPHA,MACH,DCR,PHC1)                                    015300
      PHIC = PHC1 + 90.0                                                015310
      RADB = D/(2.*S)                                                   015320
      IF(PHI.GT.PHIC) GO TO 10                                          015330
      CALL LOOK2(KY,TKY,10,ALPHA,TALPHA,10,MACH,TMACH,6,IX,IY,1)        015340
      CALL LOOK2(YCP,TYCPT,11,RADB,TRADB,11,LAMDA,TLAMDA,3,IX,IY,1)     015350
      YCPT = KY*YCP                                                     015360
      IF(PHI.LE.90.0) GO TO 15                                          015370
      YCPTT = YCPT                                                      015380
      YCPT = YCPTT+((PHI-90.0)/(PHIC-90.0))**3 * (1.0-YCPTT)            015390
      GO TO 15                                                          015400
   10 CONTINUE                                                          015410
      YCPT = 1.0                                                        015420
   15 CONTINUE                                                          015430
      RETURN                                                            015440
      END                                                               015450
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      SUBROUTINE XCPTT(ALPHA,LAMDA,MACH,AR,XCPT)                        015460
C***********************************************************************015470
C                                                                      *015480
C        THIS SUBROUTINE CALCULATES THE CHORDWISE CENTER OF PRESSURE   *015490
C        /TAIL ROOT CHORD FOR AN ISOLATED TAIL PANEL, MEASURED AFT     *015500
C        FROM THE TAIL ROOT CHORD LEADING EDGE                         *015510
C                                                                      *015520
C            ALPHA=    ANGLE OF ATTACK (DEGREES)                       *015530
C            LAMDA=    TAIL TAPER RATIO                                *015540
C            MACH=     FREE STREAM MACH NUMBER                         *015550
C            AR=       TAIL ASPECT RATIO (TWO TAIL PANELS)             *015560
C            XCPT=     TAIL CHORDWISE CENTER OF PRESSURE (RETURNED     *015570
C                      VALUE)                                          *015580
C                                                                      *015590
C***********************************************************************015600
      REAL LAMDA,MACH                                                   015610
      COMMON XCP90,XCPA,DELXCP,FMACH,DDXCP,XCP160,XP160,XCPD,SI,B,C     015620
      DIMENSION XCP90T(21),XCP9LM(21),                                  015630
     *          XCPAT(20,3,3),XCPALF(20),XCPALM(3),XCPAAR(3),           015640
     *          XCPDT(14,3,3),XCPDMC(14),XCPDLM(3),XCPDAR(3),           015650
     *          FMACHT(14,4),FMACHM(14),FMACHA(4),                      015660
     *          DDXCPT(21),DDXM(21)                                     015670
      DATA (XCP9LM(I),I=1,21)/0.,.051,.1,.152,.201,.252,.301,.35,.402,  015680
     1.451,.502,.551,.6,.652,.701,.752,.801,.852,.902,.951,1./          015690
      DATA (XCP90T(I),I=1,21)/.667,.665,.662,.659,.655,.649,.641,.635,  015700
     1.627,.619,.61,.601,.592,.582,.57,.561,.549,.537,.526,.513,.5/     015710
      DATA (((XCPAT(I,J,K),I=1,20),J=1,3),K=1,3)/.662,.662,.659,.650,   015720
     1.647,.647,.647,.647,.647,.654,.662,.676,.699,.725,.752,.789,.816, 015730
     2.858,.924,1.005,.422,.422,.468,.515,.527,.534,.542,.551,.566,.588,015740
     3.613,.645,.667,.674,.676,.686,.718,.765,.836,.919,.118,.118,.199, 015750
     4.306,.365,.397,.419,.439,.461,.480,.498,.517,.534,.547,.551,.561, 015760
     5.596,.657,.757,.848,.652,.652,.645,.623,.615,.625,.637,.650,.657, 015770
     6.654,.662,.723,.74,.745,.745,.752,.784,.843,.926,1.064,.402,.402, 015780
     7.449,.502,.537,.544,.556,.578,.583,.593,.608,.630,.645,.645,.65,  015790
     8.662,.676,.745,.846,.978,.228,.228,.284,.368,.404,.429,.441,.446, 015800
     9.446,.446,.495,.505,.517,.532,.547,.551,.559,.618,.694,.811,.635, 015810
     *.635,.630,.627,.603,.603,.637,.652,.657,.662,.667,.681,.699,.711, 015820
     1.723,.730,.755,.792,.863,.902,.471,.471,.498,.534,.547,.549,.556, 015830
     2.571,.578,.593,.613,.623,.630,.637,.642,.647,.662,.696,.757,.873, 015840
     3.216,.216,.301,.373,.407,.426,.446,.456,.471,.483,.495,.507,.517, 015850
     4.527,.539,.547,.561,.598,.694,.775/                               015860
      DATA (XCPALF(I),I=1,20)/0.,5.,10.,20.,30.,40.,50.,60.,70.,80.,90.,015870
     1100.,110.,120.,130.,140.,150.,160.,170.,180./                     015880
      DATA (XCPALM(I),I=1,3)/0.,.5,1./                                  015890
      DATA (XCPAAR(I),I=1,3)/.5,1.,2./                                  015900
      DATA (((XCPDT(I,J,K),I=1,14),J=1,3),K=1,3)/1.01,1.012,1.01,1.006, 015910
     1.973,.954,.948,.934,.909,.882,.863,.852,.846,.844,.9,.908,        015920
     2.918,.918,.895,.873,.856,.836,.807,.771,.745,.732,.726,.723,      015930
     3.884,.876,.858,.846,.809,.775,.744,.724,.708,.679,.654,.634,      015940
     4.620,.609,.988,1.018,1.063,1.065,1.01,.942,.898,.865,.852,.845,   015950
     5.841,.830,.809,.777,.926,.94,.996,.989,.887,.829,.785,.75,.723,   015960
     6.706,.695,.686,.680,.674,.808,.824,.823,.814,.771,.705,.649,.614, 015970
     7.59,.584,.584,.583,.583,.583,.935,.934,.916,.903,.874,.849,.825,  015980
     8.803,.783,.766,.749,.739,.739,.751,.861,.874,.882,.874,.777,.726, 015990
     9.696,.681,.669,.663,.664,.668,.676,.684,.755,.776,.786,.78,.668,  016000
     *.634,.618,.606,.596,.589,.585,.599,.62,.665/                      016010
      DATA (XCPDMC(I),I=1,14)/.6,.8,.97,1.,1.2,1.4,1.6,1.8,2.,2.2,2.4,  016020
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      12.6,2.8,3./                                                    016030
       DATA (XCPDLM(I),I=1,3)/0.,.5,1./                               016040
       DATA (XCPDAR(I),I=1,3)/.5,1.,2./                               016050
       DATA ((FMACHT(I,J),I=1,14),J=1,4)/.028,.030,.028,-.019,-.2,-.284, 016060
      1-.345,-.503,-.589,-.628,-.645,-.65,-.643,-.628,.072,.07,.067,   016070
      2-.019,-.196,-.272,-.382,-.557,-.645,-.687,-.687,-.665,-.64,-.616, 016080
      3.114,.116,.116,-.026,-.196,-.269,-.372,-.503,-.594,-.621,-.616, 016090
      4-.589,-.549,-.483,.151,.156,.163,-.026,-.2,-.274,-.314,-.314,  016100
      5-.309,-.306,-.301,-.294,-.284,-.277/                           016110
       DATA (FMACHM(I),I=1,14)/.6,.8,.88,1.,1.2,1.4,1.6,1.8,2.,2.2,2.4, 016120
      12.6,2.8,3./                                                    016130
       DATA (FMACHA(I),I=1,4)/.5,1.,1.5,2./                           016140
       DATA (DDXCPT(I),I=1,21)/.0,-.007,-.013,-.02,-.026,-.032,-.038,  016150
      1-.044,-.049,-.055,-.06,-.065,-.069,-.074,-.078,-.082,-.086,-.089, 016160
      2-.093,-.096,-.1/                                               016170
       DATA (DDXM(I),I=1,21)/1.,1.1,1.2,1.3,1.4,1.5,1.6,1.7,1.8,1.9,2., 016180
      12.1,2.2,2.3,2.4,2.5,2.6,2.7,2.8,2.9,3./                        016190
       PI = 3.14159265                                                016200
       RAD = PI/180.                                                  016210
       CALL LOOK1(XCP90,XCP90T,LAMDA,XCP9LM,21,IX,1)                  016220
       IF(ALPHA.GT. 90.) GO TO 10                                     016230
       CALL LOOK3(XCPA,XCPAT,20,3,ALPHA,XCPALF,20,LAMDA,XCPALM,3,AR,  016240
      +XCPAAR,3,IX,IY,IZ,1)                                           016250
       DELXCP = XCP90-XCPA                                            016260
       CALL LOOK2(FMACH,FMACHT,14,MACH,FMACHM,14,AR,FMACHA,4,IX,IY,1) 016270
       XCPT = XCP90 - DELXCP*(1.+FMACH)                               016280
       RETURN                                                         016290
    10 CALL LOOK3(XCP160,XCPAT,20,3,160.,XCPALF,20,LAMDA,XCPALM,3,AR, 016300
      +XCPAAR,3,IX,IY,IZ,1)                                           016310
       CALL LOOK3(XCPD,XCPDT,14,3,MACH ,XCPDMC,14,LAMDA,XCPDLM,3,AR,  016320
      +XCPDAR,3,IX,IY,IZ,1)                                           016330
       IF(MACH.GT. 1.) GO TO 20                                       016340
       DDXCP = 0.                                                     016350
       GO TO 30                                                       016360
    20 CALL LOOK1(DDXCP,DDXCPT,MACH,DDXM,21,IX,1)                     016370
    30 XP160 = XCP160 + DDXCP                                         016380
       IF(ALPHA .GT. 90. .AND. ALPHA .LT. 160.) GO TO 40              016390
       DXCP = XCPD - XP160                                            016400
       SI = (XP160-XCP90)/(PI*(70./180.))                             016410
       A = ALPHA*RAD                                                  016420
       B = 112.75928 - 81.4741*A + 14.58789*A**2                      016430
       C = -32.57471 + 22.32992*A - 3.61911*A**2                      016440
       XCPT = XCPD + B*DXCP + C*SI                                    016450
       RETURN                                                         016460
    40 CALL LOOK3(XCP90,XCPAT,20,3,90.  ,XCPALF,20,LAMDA,XCPALM,3,AR, 016470
      + XCPAAR,3,IX,IY,IZ,1)                                          016480
       XCPT = XCP90 + (XP160-XCP90)*(ALPHA-90.)/70.                   016490
       RETURN                                                         016500
       END                                                            016510
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      SUBROUTINE PHCC(ALPHA,MACH,DCR,PHC1)                              016520
C***********************************************************************016530
C     THIS SUBROUTINE CALCULATES PHC1, A VALUE REQUIRED BY SEVERAL     *016540
C     OTHER MARTIN METHODOLOGY SUBROUTINES                             *016550
C                                                                      *016560
C        ALPHA      = ANGLE OF ATTACH                                  *016570
C        MACH       = MACH NUMBER                                      *016580
C        DCR        = RATIO OF BODY DIAMETER TO TAIL ROOT CHORD        *016590
C                                                                      *016600
C***********************************************************************016610
      REAL MACH                                                         016620
      DIMENSION PC1M2(19,12,3),PC1M2A(19),PC1M2M(12),PC1M2D(3)          016630
      DATA ((PC1M2(I,J,1),I=1,19),J=1,6)/57.26,56.75,55.73,54.23,52.06, 016640
     148.86,45.24,42.46,40.95,39.31,37.57,36.07,34.31,32.79,31.20,29.95,016650
     228.89,27.85,26.85,90.1,89.28,87.28,83.79,80.08,74.14,67.11,63.27, 016660
     360.74,58.56,56.74,54.97,53.49,52.06,50.89,49.3,47.98,46.48,45.03, 016670
     4129.48,128.31,125.43,120.97,115.08,102.29,92.15,84.17,78.28,73.80,016680
     569.90,67.41,65.90,65.01,65.01,65.01,66.20,67.72,71.82,176.22,     016690
     6176.22,170.72,159.49,145.67,131.25,117.72,107.03,97.75,91.33,86.1,016700
     783.04,81.18,80.08,80.08,81.54,86.1,93.,105.11,230.25,             016710
     8230.25,218.06,194.7,176.22,158.77,145.01,133.65,125.43,119.33,    016720
     9116.86,116.62,118.79,120.97,126.,131.85,139.22,144.36,149.01,     016730
     *291.45,284.92,266.19,237.67,211.25,190.33,176.22,166.139,160.95,  016740
     1158.77,158.05,160.95,166.13,174.63,186.07,196.47,202.8,202.8,196./016750
      DATA ((PC1M2(I,J,1),I=1,19),J=7,12)/360.65,349.38,324.94,286.21,  016760
     1252.10,229.21,214.14,206.51,204.65,206.51,210.29,217.07,226.11,   016770
     2237.67,247.57,255.55,262.59,257.88,239.84,432.34,415.05,386.02,   016780
     3335.42,295.44,272.29,259.05,255.55,256.71,261.41,269.83,279.80,   016790
     4290.13,303.58,314.79,323.47,330.89,320.55,296.78,515.93,499.82,   016800
     5456.50,391.31,346.23,329.39,322.01,320.55,320.55,326.42,333.9,    016810
     6343.11,357.39,368.91,386.02,396.66,405.75,407.6,400.27,610.14,    016820
     7588.41,532.57,452.38,402.09,387.77,382.54,386.02,389.53,394.87,   016830
     8403.92,415.05,428.44,442.25,456.5,469.09,482.02,490.84,499.82,    016840
     9711.80,689.57,615.7,523.,462.75,446.27,442.25,444.26,454.44,469.1,016850
     *488.62,504.37,520.63,532.57,547.25,557.26,562.34,567.46,570.04,   016860
     1815.48,775.82,702.19,610.14,537.42,506.66,495.31,497.566,520.63,  016870
     2547.25,577.84,599.18,621.3,635.55,644.25,650.11,647.17,641.33,    016880
     3626.96/                                                           016890
      DATA ((PC1M2(I,J,2),I=1,19),J=1,6)/57.74,57.26,55.98,54.47,52.06, 016900
     149.08,45.23,42.65,41.31,41.13,41.69,42.65,43.43,42.84,41.5,40.02, 016910
     238.77,37.73,36.72,90.1,89.69,87.68,84.56,80.44,74.82,67.41,63.55, 016920
     361.29,59.91,59.1,59.1,59.37,59.91,60.19,61.04,60.19,59.11,58.04,  016930
     4130.06,128.89,126.,121.51,115.08,102.75,92.58,84.94,78.64,73.8,   016940
     570.21,68.02,66.2,65.6,65.3,66.2,69.9,76.88,85.71,176.22,177.02,   016950
     6170.72,160.95,145.67,131.25,117.72,117.52,98.20,91.74,86.89,83.41,016960
     781.54,80.44,80.44,81.91,86.49,94.7,105.11,231.29,232.34,219.05,   016970
     8197.36,176.22,160.22,145.01,134.87,126.57,120.42,117.19,117.19,   016980
     9118.79,121.51,126.57,133.05,139.85,145.01,149.69,294.1,286.21,    016990
     *267.4,237.67,210.29,191.2,176.22,166.14,160.95,159.49,158.77,     017000
     1160.95,166.13,173.84,185.23,198.26,203.73,204.65,198.26/          017010
      DATA ((PC1M2(I,J,2),I=1,19),J=7,12)/362.28,352.56,326.42,286.21,  017020
     1253.24,230.25,214.14,205.51,204.65,206.51,209.34,217.07,226.11,   017030
     2237.67,248.69,256.71,263.79,259.05,239.84,432.34,416.94,387.77,   017040
     3335.42,298.13,276.77,260.22,256.71,256.71,260.22,267.4,278.53,    017050
     4292.77,304.96,314.79,324.94,332.39,323.47,298.13,515.93,502.09,   017060
     5456.5,393.08,347.8,330.89,322.01,320.55,320.55,324.94,333.9,      017070
     6346.23,359.02,373.96,387.77,398.46,405.75,407.6,400.27,607.38,    017080
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7593.77,532.57,452.36,403.92,387.77,382.54,386.02,389.53,396.66,    017090
8407.6,418.83,434.3,446.27,458.58,466.97,479.84,488.62,499.82,      017100
9705.38,686.45,618.49,518.28,464.86,448.3,442.25,444.26,452.38,     017110
*469.09,493.07,508.97,523.,534.99,544.77,552.23,559.79,564.89,      017120
1570.04,815.48,775.82,702.19,610.14,537.42,508.97,495.31,499.82,    017130
2520.63,549.74,585.75,610.14,629.81,638.43,644.25,650.11,650.11,    017140
3638.,626.96/                                                       017150
 DATA ((PC1M2(I,J,3),I=1,19),J=1,6)/58.04,57.26,56.23,54.47,52.3,   017160
149.08,45.23,42.65,41.5,41.5,41.88,42.65,43.23,44.02,44.42,44.83,   017170
245.03,45.23,45.65,90.92,90.1,88.08,84.56,80.44,74.46,67.41,63.84,  017180
361.29,59.37,59.1,59.64,59.91,60.46,61.01,61.85,62.69,63.,64.13,130017190
4.06,128.89,126.,121.51,115.08,102.29,92.58,84.56,79.,74.14,70.53,  017200
568.02,66.20,65.3,65.3,66.5,70.21,77.23,85.71,177.02,177.02,171.49,017210
6160.95,147.,131.25,118.25,108.01,98.2,92.16,86.89,83.41,81.54,     017220
780.44,80.74,82.29,86.49,94.27,105.11,231.29,232.34,220.04,198.26,  017230
8177.02,160.95,146.33,135.48,126.,119.87,117.19,117.19,118.79,      017240
9122.07,126.57,133.05,139.85,145.01,149.69,294.1,287.51,269.83,     017250
*238.75,211.25,192.07,177.02,166.89,161.68,159.49,159.49,160.95,    017260
1166.13,174.63,185.23,197.36,203.73,204.65,199.16/                  017270
 DATA ((PC1M2(I,J,3),I=1,19),J=7,12)/363.93,350.97,326.42,287.51,   017280
1253.24,232.34,215.11,207.45,205.58,207.45,211.25,217.07,227.14,    017290
2236.6,247.57,255.55,264.98,260.22,239.84,434.3,418.83,389.53,      017300
3336.94,298.13,274.77,262.59,256.71,257.88,262.59,271.06,279.8,     017310
4291.45,303.58,314.79,324.94,332.39,323.47,296.78,518.28,504.37,    017320
5460.66,393.08,350.97,332.39,323.47,322.01,322.01,326.42,333.9,     017330
6344.66,357.39,372.27,386.02,396.66,403.92,407.6,400.27,612.91,     017340
7596.47,534.99,458.58,405.75,389.53,384.27,387.77,391.3,398.46,     017350
8405.75,416.94,432.34,446.27,456.5,466.97,479.84,490.84,499.82,     017360
9715.04,692.71,621.3,525.37,466.97,448.3,442.25,444.26,456.5,469.1,017370
*488.62,504.37,520.63,532.57,544.77,552.23,559.79,564.89,572.63,    017380
1819.19,782.89,708.58,612.91,539.86,506.66,495.31,499.82,520.63,    017390
2549.74,583.1,604.63,624.13,635.55,644.25,647.17,647.17,641.33,     017400
3626.96/                                                            017410
 DATA (PC1M2A(I),I=1,19)/0.,2.5,5.,7.5,10.,12.5,15.,17.5,20.,22.,25017420
1.,27.5,30.,32.5,35.,37.5,40.,42.5,45./                             017430
 DATA (PC1M2M(I),I=1,12)/.8,1.,1.2,1.4,1.6,1.8,2.0,2.2,2.4,2.6,2.8,017440
13.0/                                                               017450
 DATA (PC1M2D(I),I=1,3)/.5,.75,1./                                  017460
 IF(DCR.GE.1.) DCR=1.                                               017470
 IF(DCR.LE. .5) DCR=.5                                              017480
 CALL LOOK3(PHC1M2,PC1M2,19,12,ALPHA,PC1M2A,19,MACH,PC1M2M,12,DCR, 017490
*PC1M2D,3,IX,IY,IZ,1)                                               017500
 PHC1 = PHC1M2/MACH**2                                              017510
 RETURN                                                             017520
 END                                                                017530
```

```
      SUBROUTINE AXIAL(LAD,LND,MACH,AWOR,ALPHA,RN,CA)
C***********************************************************************
C      THIS PROGRAM CALCULATES THE AXIAL FORCE COEFFICIENT ON THE BODY *
C                                                                      *
C        LAD     =     LENGTH OF AFTER-BODY DIVIDED BY BODY DIAMETER   *
C        LND     =     LENGTH OF NOSE DIVIDED BY BODY DIAMETER         *
C        MACH    =     MACH NUMBER                                     *
C        ALPHA   =     ANGLE OF ATTACK                                 *
C        RN      =     REYNOLDS NUMBER                                 *
C        CA      =     AXIAL FORCE COEFFICIENT                         *
C                                                                      *
C***********************************************************************
      DIMENSION TLAD(4),TLND(3),TMACH(12),TRN(14),TCAOCA(14),TCDB(12),
     $TCA1B(8,4,3),TMACH1(8)
      REAL LAD,LND,MACH
      DATA(TLAD(I),I=1,4)/6.0,10.0,15.0,18.0/
      DATA(TLND(I),I=1,3)/1.5,2.5,3.5/
      DATA(TMACH(I),I=1,12)/0.6,0.7,0.8,0.9,1.0,1.1,1.2,1.3,1.5,2.0,2.5,
     $3.0/
      DATA(TMACH1(I),I=1,8)/.6,.7,.8,.9,1.,1.1,1.2,1.3/
      DATA(TRN(I),I=1,14)/1.05E06,1.15E06,1.3E06,1.55E06,1.85E06,2.55E0
     $6,3.6E06,4.7E06,6.25E06,8.3E06,10.25E06,12.05E06,14.35E06,16.3E06/
      DATA(TCAOCA(I),I=1,14)/4.45,4.05,3.625,3.038,2.65,2.313,2.013,1.76
     $3,1.525,1.325,1.2,1.113,1.05,1.025/
      DATA(TCDB(I),I=1,12)/0.135,0.139,0.145,0.160,0.184,0.222,0.217,0.2
     $08,0.194,0.158,0.125,0.099/
      DATA(((TCA1B(I,J,K),I=1,8),J=1,4),K=1,3)/0.316,0.316,0.318,0.350,
     $0.453,0.547,0.593,0.608,0.51,
     $0.51,0.515,0.542,0.630,0.739,0.795,0.812,0.817,0.817,0.825,0.844,
     $0.935,1.036,1.095,1.120,0.967,0.972,0.972,0.997,1.088,1.184,1.240,
     $1.265,0.322,0.324,0.324,0.327,0.396,0.456,0.463,0.463,0.518,0.518,
     $0.520,0.528,0.590,0.652,0.664,0.667,0.751,0.751,0.766,0.798,0.865,
     $0.900,0.905,0.910,0.907,0.912,0.932,0.959,1.004,1.039,1.054,1.059,
     $0.329,0.329,0.332,0.334,0.364,0.403,0.426,0.448,0.525,0.528,0.528,
     $.530,.560,.600,.609,.612,.788,0.793,0.793,0.793,0.883,0.870,0.887,
     $0.885,0.925,0.927,0.927,0.932,0.982,1.019,1.011,1.016/
      CALL LOOK1(CDB,TCDB,MACH,TMACH,12,IX,1)
      ALPHAP = (9.0/7.0)*SIN((ALPHA-90.0)/57.2957)*57.2957
      IF(MACH.GT.1.3) GO TO 70
      CALL LOOK1(CAOCA,TCAOCA,RN,TRN,14,IX,1)
      CALL LOOK3(CA1B,TCA1B,8,4,MACH,TMACH1,8,LAD,TLAD,4,LND,TLND,3,IX,
     $IY,IZ,1)
      CA1 = (CA1B-(0.04*LAD))*CAOCA
      CAO = CA1 + CDB
      IF (ALPHA.LT.20.0) GO TO 10
      IF(ALPHA.GT.90.) GO TO 20
      CABAR = -1.3 + 1.42857*(MACH-0.6)
      FFMA = -0.844489*(ALPHA/57.2957) + 1.92007*(ALPHA/57.2957)**2 -
     $ 1.445868*(ALPHA/57.2957)**3 + 0.360182*(ALPHA/57.2957)**4 +
     $ CABAR*(0.147331*(ALPHA/57.2957) - 1.84236*(ALPHA/57.2957)**2 +
     $4.913366*(ALPHA/57.2957)**3 - 2.419275*(ALPHA/57.2957)**4)
      GO TO 30
   10 FFMA = -SIN(ALPHA/57.2957)**2
   30 CA = CAO +FFMA
      GO TO 40
   20 CAPI = -(2.9217-9.1867*(MACH)+14.0023*(MACH)**2-8.7943*(MACH)**3+
     $2.4985*(MACH)**4-0.2658*(MACH)**5)
```

```
SUBROUTINE AXIAL       74/74    OPT=1                       FTN 4.2+74355       04/27/78  14.19.37.        PAGE      2

          IF(ALPHA.GE. 160.) GO TO 15                                                019140
          CA = CAO-(CAO-CAPI)*SIN(ALPHAP/57.2957)                                    019150
          GO TO 40                                                                   019160
       15 CONTINUE                                                                   019170
          CA = CAPI                                                                  019180
          GO TO 40                                                                   019190
       70 IF(ALPHA.GT.90.) GO TO 50                                                  019200
          CAW =(-0.0008 + 0.1501*(MACH/LND) + 0.3641*(MACH/LND)**2 + 0.0928*019210
         $(MACH/LND)**3 - 0.0409*(MACH/LND)**4 + 0.004*(MACH/LND)**5)/(0.7* 019220
         $MACH**2)                                                                   019230
          CALL CSF(RN,MACH,CF)                                                       019240
          CASF = (4.0/5.0)*CF*AWOR                                                   019250
          CAO = CAW + CASF +CDB                                                      019260
          CA = CAO                                                                   019270
          GO TO 40                                                                   019280
       50 IF(ALPHA.GE. 160.) GO TO 60                                                019290
          CAPI = -(2.9217-9.1867*(MACH)+14.0023*(MACH)**2-8.7943*(MACH)**3+ 019300
         $2.4985*(MACH)**4-0.2658*(MACH)**5)                                         019310
          CA = CAO-(CAO-CAPI)*SIN(ALPHAP/57.2957)                                    019320
          GO TO 40                                                                   019330
       60 CAPI = -(2.9217-9.1867*(MACH)+14.0023*(MACH)**2-8.7943*(MACH)**3+ 019340
         $2.4985*(MACH)**4-0.2658*(MACH)**5)                                         019350
          CA = CAPI                                                                  019360
       40 CONTINUE                                                                   019370
          RETURN                                                                     019380
          END                                                                        019390
```

```
      SUBROUTINE CSF(RN,MACH,CF)                                        019400
C***********************************************************************019410
C     THIS PROGRAM CALCULATES THE SKIN FRICTION COEFFICIENT ON THE BODY *019420
C                                                                       *019430
C        RN       =      REYNOLDS NUMBER                                *019440
C        MACH     =      MACH NUMBER                                    *019450
C        CF       =      SKIN FRICTION COEFFICIENT                      *019460
C                                                                       *019470
C***********************************************************************019480
      REAL MACH,LAM                                                     019490
      G = 1.4                                                           019500
      LAM = 1.0/SQRT((2.0/((G-1.0)*MACH**2))+1.0)                       019510
      CF1 = 0.074*(1.0/RN**.2)*1.0/(1.0+(0.9*(G-1.0)/2.0)*MACH**2)**.44 019520
      FCF1  = (ASIN(LAM)/LAM)*1.0/SQRT(1.0+((G-1.0)/2.0)*MACH**2)*(.242/019530
     $SQRT(CF1))-ALOG10(CF1*RN)+1.26*(ALOG10(1.+((G-1.)/2.)*MACH**2))   019540
      CF2 = CF1 + 0.00001                                               019550
      FCF2  = (ASIN(LAM)/LAM)*1.0/SQRT(1.0+((G-1.0)/2.0)*MACH**2)*(.242/019560
     $SQRT(CF2))-ALOG10(CF2*RN)+1.26*(ALOG10(1.+((G-1.)/2.)*MACH**2))   019570
      N = 1                                                             019580
   10 DCFODF = ((CF2-CF1)/(FCF2-FCF1))                                  019590
      CF3 = CF2 - DCFODF*FCF2                                           019600
      IF(FCF2.LT.0.0) GO TO 15                                          019610
      CF3 = CF1 - DCFODF*FCF1                                           019620
   15 N = N + 1                                                         019630
      FCF3  = (ASIN(LAM)/LAM)*1.0/SQRT(1.0+((G-1.0)/2.0)*MACH**2)*(.242/019640
     $SQRT(CF3))-ALOG10(CF3*RN)+1.26*(ALOG10(1.+((G-1.)/2.)*MACH**2))   019650
      IF(ABS(FCF3).LE.0.000001) GO TO 20                                019660
      CF1 = CF2                                                         019670
      FCF1 = FCF2                                                       019680
      CF2 = CF3                                                         019690
      FCF2 = FCF3                                                       019700
      IF(N.GT.50.0) GO TO 30                                            019710
      GO TO 10                                                          019720
   20 CF = CF3                                                          019730
      GO TO 50                                                          019740
   30 WRITE(6,35)                                                       019750
   35 FORMAT(1H0,* THE ITERATION HAS  GONE THROUGH 50 CYCLES*)          019760
   50 CONTINUE                                                          019770
      RETURN                                                            019780
      END                                                               019790
```

```
SUBROUTINE LOOK1       74/74    OPT=1                        FTN 4.2+74355      04/27/78  14.19.33.       PAGE     1

              SUBROUTINE LOOK1(F,FT,X,XT,NX,IX,MULT)                                017540
        C*********************************************************************017550
        C   ONE-DIMENSIONAL TABLE LOOKUP ROUTINE  (* = RETURNED VALUES)            017560
        C     *F             = FT(X)                                               017570
        C      FT            FUNCTION TABLE  FT(NR)                                017580
        C      NR            NO. OF ROWS IN FT-TABLE                               017590
        C      NC            NO. OF COLUMNS IN FT-TABLE                            017600
        C      X             WORKING VALUE OF INDEPENDENT VARIABLE                 017610
        C      XT            INDEPENDENT VARIABLE TABLE                            017620
        C      NX            DIMENSION OF XT TABLE                                 017630
        C     *IX            X  INDEX ON PRIVIOUS LOOKUP  (UPDATED ON EACH CALL)   017640
        C      MULT          =0,  USE PREVIOUS X                                   017650
        C                    =1,  LOOKUP NEW X                                     017660
        C*********************************************************************017670
              DIMENSION FT(1),XT(1)                                                017680
              IF(MULT-1)2,1,2                                                      017690
            1 CALL INDEX(X,XT,NX,IX,KEEP,RX)                                       017700
            2 F=FT(IX)                                                             017710
              IF(KEEP-1)3,4,3                                                      017720
            3 F=(FT(IX+1)-F)*RX+F                                                  017730
            4 RETURN                                                               017740
              END                                                                  017750
```

```
      SUBROUTINE LOOK3(F,FT,NR,NC,X,XT,NX,Y,YT,NY,Z,ZT,NZ,IX,IY,IZ,MULT)017760
C*****************************************************************017770
C   THREE-DIMENSIONAL TABLE LOOKUP ROUTINE  (* = RETURNED VALUES)      017780
C     F             =FT(X,Y,Z)  (RETURNED VALUR)                       017790
C     FT            FUNCTION TABLE FT(NR,NC,NP)                        017800
C     NR            NO. OF ROWS IN FT-TABLE                            017810
C     NC            NO. OF COLUMNS IN FT-TABLE                         017820
C     X,Y,Z         WORKING VALUES OF INDEPENDENT VARIABLES            017830
C     XT,YT,ZT      INDEPENDENT VARIABLE TABLES                        017840
C     NX,NY,NZ      DIMENSION OF XT,YT,ZT TABLES                       017850
C    *IX,IY,IZ      X,Y,Z INDEXES ON PREVIOUS LOOKUP (UPDATED ON EACH CAL017860
C     MULT          =0, USE PREVIOUS X,Y,Z                             017870
C                   =1, LOOK UP NEW X,Y,Z                              017880
C*****************************************************************017890
      DIMENSION FT(1),XT(1),YT(1),ZT(1)                                017900
      IF(MULT-1)2,1,2                                                  017910
    1 CALL INDEX(Z,ZT,NZ,IZ,KEEP,RZ)                                   017920
      I = 1+(IZ-1)*NR*NC                                               017930
      II = I+NR*NC                                                     017940
    2 CALL LOOK2(F,FT(I),NR,X,XT,NX,Y,YT,NY,IX,IY,MULT)                017950
      IF(KEEP-1)3,4,3                                                  017960
    3 CALL LOOK2(F2,FT(II),NR,X,XT,NX,Y,YT,NY,IX,IY,1)                 017970
      F=(F2-F)*RZ+F                                                    017980
    4 RETURN                                                           017990
      END                                                              018000
```

```
      SUBROUTINE LOOK2(F,FT,NR,X,XT,NX,Y,YT,NY,IX,IY,MULT)              018320
C***********************************************************************018330
C     TWO-DIMENSIONAL TABLE LOOKUP ROUTINE  (* = RETURNED VALUES)       018340
C     F              =FT(X,Y)                                           018350
C     FT             FUNCTION TABLE FT(NR,NC)                           018360
C     NR             NO. OF ROWS IN FT-TABLE                            018370
C     NC             NO. OF COLUMNS IN FT-TABLE                         018380
C     X,Y            WORKING VALUES OD INDEPENDENT VARIABLES            018390
C     XT,YT,         INDEPENDENT VARIABLE TABLES                        018400
C     NX,NY          DIMENSION OF XT,YT,TABLES                          018410
C    *IX,IY          X,Y  INDEXES ON PREVIOUS LOOKUP (UPDATED ON EACH CALL018420
C     MULT           =0,  USE PREVIOUS X,Y                              018430
C                    =1,  LOOKUP NEW X,Y                                018440
C***********************************************************************018450
      DIMENSION FT(1),XT(1),YT(1)                                       018460
      IF(MULT-1)2,1,2                                                   018470
    1 CALL INDEX(Y,YT,NY,IY,KEEP,RY)                                    018480
      I = 1+(IY-1)*NR                                                   018490
      II = I+NR                                                         018500
    2 CALL LOOK1(F,FT(I),X,XT,NX,IX,MULT)                               018510
      IF(KEEP-1)3,4,3                                                   018520
    3 CALL LOOK1(F2,FT(II),X,XT,NX,IX,1)                                018530
      F=(F2-F)*RY+F                                                     018540
    4 RETURN                                                            018550
      END                                                               018560
```

```
      SUBROUTINE INDEX(X,XT,NX,IX,KEEP,RATIO)                           018010
C************************************************************************018020
C  TABLE INDEX LOOKUP ROUTINE  (* = RETURNED VALUES)                    018030
C     X              WORKING VALUE OF INDEPENDENT VARIABLE              018040
C     XT             INDEPENDENT VARIABLE TABLE  XT(NX)                 018050
C     NX             DIMENSION ON X-TABLE                               018060
C     IX             INDEX OF PREVIOUS LOOKUP (UPDATED EACH CALL)       018070
C    *KEEP           =0   X.NE.ANY XT. INTERPLOATION WAS REQUIRED.      018080
C                    =1   X.EQ.XT(IX). INTERPOLATION NOT REQUIRED.      018090
C    *RATIO          INTERPOLATION RATIO                                018100
C************************************************************************018110
      DIMENSION XT(1)                                                   018120
      RATIO = 0.                                                        018130
      KEEP = 0                                                          018140
      IF(NX-IX)1,1,2                                                    018150
    1 IX = NX-1                                                         018160
    2 IF(IX-1)3,3,4                                                     018170
    3 IX = 1                                                            018180
    4 IF(NX-1)10,10,5                                                   018190
    5 IF(XT(IX)-X)6,10,7                                                018200
    6 IF(XT(IX+1)-X)8,9,11                                              018210
    7 IX = IX-1                                                         018220
      IF(IX-1)9,5,5                                                     018230
    8 IX = IX+1                                                         018240
      IF(IX-NX)5,10,10                                                  018250
    9 IX = IX+1                                                         018260
   10 KEEP = 1                                                          018270
      RETURN                                                            018280
   11 RATIO = (X-XT(IX))/(XT(IX+1)-XT(IX))                              018290
      RETURN                                                            018300
      END                                                               018310
```

Appendix B. DESCRIPTION OF SUBROUTINES AND PROGRAM LISTING

Table B-1 lists the subroutines and gives their basic function.

A detailed description of each subroutine will not be included in this report. The logic and procedures required of each included method are discussed in detail in Reference 1. The applicable section of Reference 1 for each of the Methodology Program Subroutines is listed in Table B-1.

TABLE B-1. LIST OF PROGRAM ELEMENTS

SUBPROGRAM NAME	REF. 1 SECTION	FUNCTION OF SUBPROGRAM
MAIN		Controls input and output to the program. Uses various subroutines to calculate aerodynamic coefficients and centers of pressure for total missile and isolated components.
CNTPHI	SEC.5.2.1	Calculates tail normal force coefficient in presence of a cylindrical body as a function of roll angle. (Angle of attack limited to 0 to 45 degrees).
CNTT	SEC.5.1.4	Calculates tail normal force coefficient of an isolated tail (angle of attack 0 to 180 degrees).
BRIT		Contains data required by several other Methodology subroutines. Data is taken from British Data Sheets. (Reference 3).
CNBOD	SEC.5.1.1	Calculates body alone normal force coefficient (angle of attack 0 to 180 degrees).
XCPBOD	SEC.5.1.2	Calculates body alone center of pressure measured in calibers from the nose. (Angle of attack 0 to 180 degrees).
IBTT	SEC.5.2.4	Calculates body normal carry over force coefficent.
XCPBTT	SEC.5.2.5	Calculates tail-to-body carry over normal force center of pressure.
XCPTBB	SEC.5.2.2	Calculates the tail chordwise center of pressure (upper and lower bound)/ tail root chord, measured aft from root chord leading edge.

SUBPROGRAM NAME	REF. 1 SECTION	FUNCTION OF SUBPROGRAM
YCPTS	SEC.5.2.3	Calculates tail spanwise center of pressure for isolated tail.
XCPTT	SEC.5.1.5	Calculates chordwise center of pressure for isolated tail for roll angle = 0.
PHCC		Required by several other Methodology Subroutines.
AXIAL	SEC.5.1.3	Calculates the axial force coefficient for the missile body.
CSF	SEC.5.1.3	Calculates the skin friction coefficient for the missile body.
LOOK1		One-dimensional table look-up subroutine.
LOOK2		Two-dimensional table look-up subroutine.
LOOK3		Three-dimensional table look-up subroutine.
INDEX		Required for subroutines LOOK1, LOOK2, and LOOK3.

A complete program listing follows.

REFERENCES

1. Aiello, G.F., "Aerodynamic Methodology (Bodies With Arbitrary Roll Angles, Transonic and Supersonic)", Final report on USAMICOM Contract DAAH01-74-C-0621, OR 14,145, April 1976.

2. Spring, D.J., Derrick, J.N., and Winn, G.C., "An Assessment of the Martin-Marietta High Angle of Attack Aerodynamic Methodology for Body-Tail Missiles", TR RD-76-33, US Army Missile Command, June 1976.

3. Royal Aeronautical Society, Data Sheets, Wings 5.01.03.03, 5.01.03.04, 5.01.03.05, and 5.01.03.06.

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